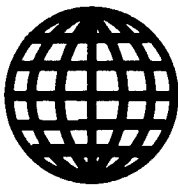


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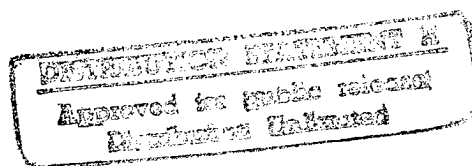


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# ***JPRS Report***

# **Science & Technology**

***China***



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# Science & Technology China

JPRS-CST-93-013

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27 July 1993

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**Taiwan: National Science Council R&D Plans,  
New Centers Described**

**Submicron Device Technology**

93P60288A Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 1, Jan 93 pp 30-31

[Unattributed article: "Submicron Device Technology Development Plan"]

[Summary] The Taiwan IC industry is now fairly mature, with the leading firms producing 0.8-0.6-micron ICs. ERSO's [Electronics Research and Service Organization] submicron plan is targeting 0.5 micron, for development of 16M DRAMs and 4M SRAMs. Initial development of 0.35-micron technology is set for 1994-1995. Scientists at the National Submicron Laboratory will cooperate with Tsing Hua University professors and several industrial firms in research on 0.35-0.25-micron device fabrication technologies.

This plan over the next 3 years will be embodied in the following eight sub-plans in four general areas:

In the area of multilayer metal interconnect technology:

- (1) Research on application of selective W-CVD for submicron ICs.
- (2) Research on diffusion blocking layers (TiW and TiN).
- (3) Smoothing of submicron-device fabrication.

In the area of device structure and fabrication technologies:

- (4) Use of high-energy ion beam implantation for ROM masks.
- (5) Research on high-energy ion beams for fabrication of 0.35-micron anti-diffused-profile double-well CMOS devices.
- (6) Research on electron-beam direct writing for development of 0.35-0.25-micron 3.3-volt-and-under devices.

In the area of polycrystalline Si thin-film transistors (TFTs):

- (7) Application of TFTs in high-density SRAMs.

In the area of Si and SiGe new materials and device fabrication technologies:

- (8) Use of CBE technique to research Si and SiGe amorphous materials growth and development of bipolar devices. Application of ultra-thin amorphous films in monolithic microwave ICs and digital ICs.

**Electroluminescent FPDs**

93P60288B Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 1, Jan 93 pp 31-32

[Unattributed article: "Development Plan for New Thin-Film Electroluminescent Flat-Panel Displays"]

[Summary] This research plan over a 3-year period is broken down into the following two sub-plans:

- (1) Development of electroluminescent (EL) devices and packaging technology.

First year: On a 200 mm x 150 mm transparent-electrode glass substrate, growth of high-quality, large-area ZnS:Mn and ZnS:Tb,F luminescent layer films and HfO<sub>2</sub>, Ta<sub>2</sub>O<sub>5</sub>, BaTiO<sub>3</sub> and other insulation layers, and development of the following EL device structures: ITO glass/BaTiO<sub>3</sub>/ZnS:Mn or ZnS:Tb,F/HfO<sub>2</sub>/Ta<sub>2</sub>O<sub>5</sub>/HfO<sub>2</sub>/Al.

Second year: Use of RIE or wet etching for etching luminescent layers (ZnS:Mn or ZnS:Tb,F), ITO, and Al, and development of dot-matrix EL devices. Scheduled completion of a 160 mm x 120 mm (effective-area) EL FPD with a resolution of 4 lines/mm and a brightness of 50 fL.

Third year: Development of packaging technology for 307,200-pixel (640 x 480) matrix EL FPDs.

- (2) Development of drive circuits and peripherals.

First year: Software design of basic drive circuits, specification design for drive-circuit peripherals, CAD simulation testing and purchase of tuning parts.

Second year: Hardware design of basic circuits, installation of connections between circuit boards and EL electrodes, testing of electrical characteristics.

Third year: Reliability testing, light-display testing.

**Domestic Satellite #1 Component Announcement**

93P60288C Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 1, Jan 93 p 32

[Unattributed article: "China [i.e., ROC] Satellite #1 Satellite Component Planning Document Tender Announcement"]

[Summary] For the project to launch China Satellite #1, it is estimated that 12 types of components can be developed and manufactured domestically, and the following tender is formally made. NSC's National Space Planning Office is holding in Taipei on 15 January 1993 an explanatory meeting to provide details on this satellite component tender, and domestic firms are asked to respond by 1 March 1993. The 12 types are as follows:

- (1) Power converters
- (2) Power regulators, supplies, and control assemblies
- (3) Attitude and orbit control electrical units
- (4) Antennas
- (5) Microwave devices (L- and S-band solid-state power amplifiers, S-band low-noise amplifiers)
- (6) Filters, diplexers
- (7) Command and data processing electrical units
- (8) Global positioning system receivers
- (9) Satellite computers
- (10) Solid-state data recorders
- (11) Electric heaters and ducts
- (12) Structural and circuit installation (structures and circuits to be manufactured by Space Planning Office/Systems Development Branch).

### Environmental Engineering

93P60288D Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 3, Mar 93 pp 177-180

[Article by Chiang Pen-Chi of the Environmental Engineering Research Institute, National Taiwan University: "Planning for Environmental Engineering Disciplines"]

[Summary] This article highlights the NSC Engineering Division's viewpoints on environmental engineering disciplines, summarizes present worldwide S&T trends, and encourages officials to make use of recent research achievements to promote the development of the domestic environmental protection industry.

NSC's domestic environmental engineering planning is based on the environmental engineering S&T development and training conferences and plans prepared by Professor Chang Ch'ing-Yuen in 1990, which emphasize the following future research areas:

#### I. Water Resources and Water Quality Safety Issues

1. Preprocessing of polluted substances in water resources.
2. Evaluation of the efficacy of traditional clean water programs on special water quality processing.
3. Generation and control of aluminum remaining in tap water.
4. Generation and control of added-chlorine disinfectant by-products (DBPs) in tap water.
5. Establishment of Surrogate Organic Parameters for domestic clean water engineering.

#### II. Waste Water Issues

1. Low-cost, energy-saving, resource-saving, technology-saving, high-efficiency waste-water processing technology.
2. Waste-water processing technology for difficult-to-decompose and toxic substances.
3. Industrial waste processing and secondary pollution control.
4. Water quality and water quantity problems and processing benefits.
5. Research on the toxicity, fatality, environmental effects, and amelioration of pollutants in polluted river systems.

#### III. Air and Noise Issues

1. Research on air pollution problems from industrial waste; emphasis on BACT (Best Available Control Technology).
2. Research on air pollution problems in metropolitan areas.
3. Research on noise problems and vibration from industrial waste emissions.
4. Research on noise problems from common waste substances.

5. Research on problems of environmental noise and vibration in metropolitan areas.

#### IV. Waste Substances Issues

1. Research on reduction, recovery, and utilization of waste substances.
2. Research on incineration processing and secondary pollution monitoring.
3. Research on monitoring, processing, and harm assessment of harmful substances.
4. Research on processing of water leaching from buried fields and on processing of incinerator residues.
5. Research on harm assessment of polluted sites, underground water pollution monitoring, and initial/repeated training in these areas.

#### V. Environmental Monitoring and Systems Analysis Issues

1. Research on continuous automatic monitoring systems for environmental quality.
2. Research on transmission of polluted substances into natural environments.
3. Research on automated control systems for polluted water plants and tap water plants.
4. Development of expert systems for environmental engineering applications.
5. Research on optimized models for environmental engineering systems planning, design, and operation.

### High-Speed Computing Center Opens

93P60288E Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 3, Mar 93 pp 223-226

[Unattributed article: "NSC's National High-Speed Computing Center Opens"]

[Summary] NSC's National High-Speed Computing Center, one of the five major national laboratories, formally opened for operations on 12 February this year. The center currently has an IBM ES9000/960 supercomputer (operating speed exceeding 2 GFLOPS), a Convex C3840 as a front-end unit, graphics workstations, and various other computers and workstations. Services provided by the center are as follows: (1) Training and consultation, (2) Interchange of knowledge and experience, (3) Computational chemistry and molecular simulation, (4) Scientific visual calculations, (5) Fluid mechanical calculations, (6) Distributed computing, (7) Ad-hoc supercomputer use, and (8) Publishing of documents and other printed products.

### Chip Design, Fabrication Center Opens

93P60288F Taipei K'OHSUEH FACHAN YUEK'AN  
[NATIONAL SCIENCE COUNCIL MONTHLY]  
in Chinese Vol 21 No 3, Mar 93 p 226

[Unattributed article: "NSC's 'Chip Design and Fabrication Center' Opens"]

[Summary] NSC has established a "Chip Design and Fabrication Center," which formally opened on 20 February 1993. The center was built with the following three objectives: chip fabrication realization, technological

examination and study, and technology development. Services will be open to all Taiwan university and institute scientists and researchers, IC industry specialists, electronics industry specialists, and even representatives of foreign institutions. The center is equipped with an ASIC [application-specific integrated circuit] database to encourage domestic IC designers to make use of the latest techniques.

### **First Chinese High-Tech Industry Established in France**

93P60298A Beijing ZHONGGUO KEXUE BAO  
[CHINESE SCIENCE NEWS] in Chinese 28 Apr 93 p 1

[Article by Li Cunfu [2621 1317 1381]]

[Summary] In order to market and globalize Chinese high-tech products, the first Chinese high-tech industry, the International Development Company, Ltd., has officially been established in Tulle Industrial Park in Southern France. To bring the products directly into the European market, the company will take advantage of the superior environment and preferential policies offered by the park to develop, produce, and sell Chinese high-tech products. With an initial investment of 1.02 million francs, the company is to focus on development, production, and sales of such high-tech products as electronic medical instruments, electronic machinery, and fine chemicals.

### **Chinese Comments on U.S. Legislation on Limitation of Nuclear Testing**

#### **Test Limitation Welcomed**

936B0088A Beijing INSTITUTE OF APPLIED PHYSICS  
AND COMPUTATIONAL MATHEMATICS in Chinese  
3 Jun 93 pp 1-9

[[Article by Liu Gongliang [0491 1872 2733] of the Institute of Applied Physics and Computational Mathematics: "Comments on the Legislation of the U.S. Congress Nuclear Testing Limits in 1992"]

[Text] In September 1992, the U.S. Congress passed legislation on the limitation of nuclear testing and imposed a 9-month "temporary moratorium on nuclear testing." After performing 15 permitted safe and reliable tests, nuclear testing will stop as of 30 September 1996. If other countries are planning to follow, the President is instructed to conduct multilateral negotiation on an overall CTB (complete testing ban). This is a major shift of U.S. policy on nuclear testing since the Reagan Administration in the 1980's. It attracted considerable concern worldwide. The following is a discussion on the nuclear testing moratorium and the implementation of CTB, as well as some personal viewpoints.

#### **I. We Welcome the New U.S. Position on Limitation of Nuclear Tests**

Our ultimate goal has always been a complete test ban, an overall ban on the use of nuclear weapons and total destruction of all nuclear weapons. Nevertheless, for nearly 40 years this goal has not been achieved. The nuclear weapons race has been very tight primarily because of the competition between the U.S. and the USSR. By the end of 1992, the U.S. had conducted 942 nuclear tests and Russia (Soviet) 715. According to some reports, several

kiloton-level tests are not included in the statistics mentioned above. The huge nuclear arsenals maintained by the U.S. and Russia, even after implementing SALT-II, still contain 3000-3500 nuclear warheads, not including warheads in stockpile and some tactical nuclear weapons. To date, the U.S. and Russia have not abandoned the strategy of nuclear threat.

Since the end of the cold war, hostilities between the U.S. and the USSR have disappeared. I personally believe that there is no need for them to further develop nuclear weapons. Therefore, it is time to stop nuclear testing. We have been calling on the U.S. and Russia to take action. Hence, we welcome this shift of U.S. policy on limitation of nuclear testing.

#### **II. We Understand the Need for Limited Testing To Resolve Safety and Reliability Issues**

The U.S. Congress claims that future nuclear tests are primarily to resolve safety and reliability issues. Since we only reviewed the unclassified portion of the report written by Professors Kidder and Drell, we are not in a position to assess the U.S. nuclear arsenal. However, as a nuclear physicist, I am concerned about the safety of nuclear warheads because it is a scientific issue affecting the environment. The TMI (Three Mile Island) incident in the U.S., the Chernobyl incident in Russia, and a number of recent nuclear accidents in the Commonwealth of Independent States are worrisome. Therefore, it is imperative that no nuclear weapon-related incidents should occur. In order to improve safety, it is understandable that tests are necessary.

Of course, the safest way is to stop deployment and completely destroy all nuclear weapons. However, it appears that the U.S. will not give up its nuclear threat strategy and intends to maintain a huge nuclear arsenal. Under the circumstance, from a scientific standpoint, it is hard to imagine that they will not conduct any nuclear tests while trying to maintain such a large nuclear arsenal. Recently, the U.S. military expressed their unwillingness to give up testing after 1996. Therefore, I have serious doubts that the U.S. can truly stop nuclear testing forever. This seems to be a major contradiction in U.S. nuclear policy.

#### **III. The Moratorium Is of No Essence to CTB**

The biggest contradiction of the U.S. Congress's legislation is its suspension of nuclear testing for 9 months, and it is hard to understand. Since the U.S. has a fixed number of tests to conduct, why don't they finish them now? Why do they impose a 9-month moratorium to further delay those tests?

Recently (on 4 May), Chairman John Deutch of the Nuclear Weapons Council testified in Congress that, "We need to continue nuclear testing after the moratorium to ensure that we have a safe, stable, reliable and effective nuclear force. Hence, the Defense Department supports resuming nuclear testing as soon as possible according to law." Based on information obtained from France, Russia, and the U.K., they also plan to proceed with nuclear testing. Therefore, it is a matter of time before tests are resumed. Hence, a moratorium or a delay has no meaning whatsoever.

The history of nuclear test bans shows that a moratorium cannot slow down the nuclear arms race and cannot lead to CTB because testing can be resumed after the moratorium is lifted. The moratorium imposed by the U.S., the U.K. and the USSR between 1958 and 1961 ended with more vigorous nuclear testing. In 1961, the USSR conducted 30 atmospheric nuclear explosions in 60 days, including the largest, a 58 Mt explosion over Novaya Zemlya. The U.S. conducted 40 atmospheric tests in 6 months. In 1985, Gorbachev announced a moratorium on nuclear testing. However, the U.S., the U.K. and France did not respond. Eighteen months later, in 1987, the USSR again conducted 23 tests in one year. This made a mockery of the moratorium. History tells us that a moratorium is usually a strategy, or the result of an internal political struggle. In April 1992, the moratorium declared by Mitterrand was apparently related to the election in France. Technically, it is a preparation stage. Incidentally, the U.S. and the USSR opposed any form of non-verifiable moratorium in their CTB talk in 1976. Hence, it is meaningless to provide any assessment of a moratorium.

Since 1964, China has conducted a very limited number of nuclear tests, basically once a year. Within this period, once there was no testing in 5 years. The situation is essentially the same for the U.K. In other words, there was a 9-month moratorium after each test for China and the U.K. Furthermore, the U.S. and the USSR have strong nuclear testing capabilities. They can concentrate all the tests needed and then pause for a period of time. This is merely a testing schedule change that renders a moratorium even more meaningless.

There is too much propaganda for this kind of moratorium. People even urge that pressure be put on countries not joining the moratorium. This is not only unreasonable but also unfair. For instance, if China declared a 1-2 year moratorium in 1985, 1986 or 1991, would the U.S. respond immediately? Obviously, it would not. Therefore, we must take a number of specific steps to combine a nuclear test ban with large-scale disarmament to create the true condition for CTB.

#### IV. Any Testing Ban Should Not Come With Pre-requisite Conditions

The testing ban after September 30, 1996, imposed by the U.S. Congress is based on the number of tests required to resolve nuclear safety issues. However, the resolution includes a pre-requisite condition that the ban will be lifted if any other country is still conducting nuclear tests. In my opinion, this condition is totally unnecessary. The impression is that the U.S. is not sincere about taking a lead in CTB. This is nothing but a political move. Or, there are disagreements internally and such a provision is made as a way out. As a matter of fact, the U.S. and Russia have conducted numerous nuclear tests to bring the technology to maturity. Hence, it is not necessary to use the testing in other countries as a pre-requisite condition. The nuclear weapons owned by the U.S. and Russia are attack-oriented, while those owned by the U.K., China and France are merely for defensive purposes. Every country has its own technical approach and is in a different development stage. However, there are some common problems. For instance, both the U.S. and Russia need to conduct nuclear tests on safety-related issues. I imagine

other countries have the same need. The U.S. and Russia have already conducted a great deal of tests. It is perfectly reasonable to ask them to stop testing first. It is unfair and impractical for the U.S. and Russia to ask other countries to stop testing at the same time.

#### V. Push for Early Realization of CTB

From the above discussion, I hope that I don't leave the impression that CTB can never be implemented or that we want to talk about a nuclear testing ban indefinitely. On the contrary, we hope for the early implementation of CTB on a global basis. We are even willing to fight for it. Nevertheless, we feel that we should study ways to implement a practical, solid and permanent CTB.

As we all know, since 1960, there have been three international or bilateral treaties on nuclear testing ban. It took 16 years for the U.S. and the USSR to rectify officially the bilateral TTBT signed in 1974. This kind of progress is too slow. Furthermore, we are concerned about the flip-flop of their positions on nuclear test bans. It is hard for us to have a handle on any new policy they propose unless we observe it for 3-5 years. In other words, there is a low level of confidence.

Under the circumstance, it is not advisable to take either extremes. One extreme is an immediate CTB. It is ideal if feasible. We also wish to have an immediate nuclear-weapon-free world. However, it is not practical. Another extreme is to do nothing. Of course, it is also not desirable. People all over the world will not stand for it. Hence, we should take some measures to push the implementation of CTB. It took 16 years for the U.S. and the USSR to take one step. If we can march forward another step in less time, it will be considerable progress.

Many people are proposing the idea of moving step by step towards a CTB. This is a scheme that is worth some in-depth investigation. There are specific approaches and they can be summarized as follows:

1. Limit the number of nuclear tests per year to 1-2, or 4 or 6.
2. Limit the yield of underground blasts to 1 kt, 10 kt, or 20 kt. Even more, we can require a specific number of 150 kt tests.
3. Limit the total number of nuclear tests for every country. Upon completion of these tests, all tests must stop.
4. Impose a time limit. After a specific time period, all tests must stop.
5. Limit yield and number of tests simultaneously, i.e., impose a quota.
6. Limit the total number of tests and time simultaneously. The legislation passed by the U.S. Congress belongs to this category.

Each scheme is an approach towards a CTB. However, they all have their advantages and disadvantages that deserve serious consideration.



Assessment of the above approaches.

- To limit the number of tests per year can stop the development of new weapons. It only allows a small number of safety and reliability tests. If the number per year is no more than 2, it should be considered a major achievement and may receive the support of many countries to become an acceptable transition step.
- A yield limit, i.e., a low-threshold test ban, in principle, is also a transition step. However, it also has its problem. If the threshold is set too high, it becomes meaningless. If the threshold is set at 1 kt, then it is hard to verify. An intermediate threshold of 10 or 20 kt may be attractive because the verification issue can be temporarily side-stepped and progress is also made.
- To limit the total number or time involves the plan and resources of individual country. It requires some discussion. If a compromise can be reached (i.e., not asking for a unilateral time limit nor an indefinite delay), it would be a feasible approach. The key is negotiation on equal footing.

Perhaps a combination of different approaches will become the commonly acceptable plan later. We should actively pursue the realization of each transition step.

During the transition stage, we should work on the following:

- Make progress in verification technology and share such technology.
- Establish credibility among different countries.
- Push for real progress in large-scale nuclear disarmament between U.S. and Russia.

We look forward to the early arrival of a CTB and a nuclear-weapon-free world.

#### Verification Issues Related to CTB

936B0088B Beijing INSTITUTE OF APPLIED PHYSICS  
AND COMPUTATIONAL MATHEMATICS in Chinese  
3 Jun 93 pp 10-14

[Article by Du Shuhua]

1. Any treaty becomes much more enforceable if it is verifiable, especially when there are sufficient means for verifications. Verification is a powerful deterrent to any attempts of violation. Verification can also provide evidence of existing violations to allow the international community to take punitive measures. Therefore, verification provides a powerful assurance for the full implementation of any nuclear treaty.
2. A nuclear test ban is an integral part of total nuclear disarmament. It is a step to stop production and deployment, [and to achieve] large-scale scale-down and complete destruction of all nuclear weapons. As complete nuclear disarmament is being studied, we should also explore and pursue a global CTB. Undoubtedly, a CTB is as significant as other nuclear disarmament issues such as stopping global nuclear arms race, preventing

nuclear proliferation, eliminating nuclear threat by one country to others and reducing dependence and worship of nuclear weapons.

3. There may be different interpretations for a CTB. In my opinion, any nuclear explosion should be banned under a CTB. The following discussion is conducted on the basis of this understanding.
4. In order to ensure that verification is effective, the verification system should meet the following basic requirements:

#### (1) Timeliness

When a violation occurs, the verification system must be capable of providing evidence in a timely manner. The purpose is to notify the international community to take early action, to apply pressure to prevent further violations from taking place. On the other hand, the violator does not have time for cover-up, diversion and disguise. This makes it harder for the violator. In addition, timeliness also should include the feasibility of detecting a potential violation during its preparation stage before it actually takes place so that actions can be taken to stop it.

#### (2) Accuracy

The verification system must provide accurate, or highly credible, information. Even though the data cannot be used to prove a violation beyond the shadow of a doubt, it must be able to serve as the basis of further verification activities.

#### (3) Reliability

Various portions of the verification system must provide consistent information on identical or similar violations without any disagreement.

#### (4) Openness

The methodology, approach and measures adopted for the verification system must be acceptable and recognized to the international community and treaty signing countries. Each treaty country has the obligation to accept international verification. In addition, it also has the privilege to share the capability and data obtained by the global verification system.

5. A timely, accurate, reliable and open verification system can meet the objective of nuclear verification. Hence, it is an effective verification. Since CTB is a multi-lateral issue, in principle, the scope of verification should include all treaty signing countries. It requires global verification. All countries should cooperate fully to build a nuclear verification system that meets the four requirements mentioned above in order to resolve the difficulties involved in the construction of such a system and to contribute to the implementation of a CTB. Technically advanced countries can do a great deal in this aspect.

6. The following is a discussion of major issues to be resolved in the construction of an effective verification system that meets the four requirements described above.

- (1) To ensure timeliness, the monitoring must be done in a timely manner. This includes two aspects, i.e., timely detection of raw signal and fast analysis and processing of data. In principle, all countries involved in verification should have such timely monitoring capability. Because the raw signal, e.g., seismic wave, arrives at different monitoring sites in different countries at different times and in different intensities, some monitoring sites may not even detect it. Therefore, there is a need to establish a timely international data exchange, information analysis and processing network to ensure that every country can participate in an effective global verification system in a timely manner.
  - (2) In order to ensure accuracy of verification, every country should share the same level of verification technology, including monitoring technology and information processing technology to enhance the credibility of the results by means of comparison, referencing and confirmation. Everyone involved should collaborate to improve the current verification level and raise its accuracy. In addition, new nuclear verification techniques should be investigated and developed to ensure their effectiveness.
  - (3) To ensure the reliability of verification, an authoritative group comprised of experts from different countries should be established to routinely assess and coordinate the global verification system. The purpose is to make sure that every country always has the same verification capability and every country can share the same information of monitoring and the same verification technology. Furthermore, verification results are assessed and validated in an overall manner to derive the final scientific conclusion. Ensuring the authority and legitimacy of verification can prevent one or a few countries from reaching a unilateral conclusion to further strengthen the reliability of nuclear verification.
  - (4) To ensure the openness of verification, the method, means and measures adopted for verification must be acceptable and usable by all countries. The data and information processing techniques are also open and shared by every country involved. Verification conducted by secret technique and methods is invalid and illegal. Hence, openness is the basis of effective verification.
7. The above is a discussion on the principle of CTB verification. On this basis, a nuclear verification system comprised of different techniques (such as seismic technique and satellite technology) can be designed and constructed. Obviously, it ought to be pointed out that any treaty is not completely verifiable. Besides the four requirements, it is equally important that the treaty be built on the basis of mutual trust and cooperation. As long as all countries cooperate, adopt and strengthen more measures to earn mutual trust and actively pursue

solutions to various problems encountered in nuclear verification, we believe that a CTB can be implemented in the near future.

### China's Nuclear Policy

936B0088C Beijing INSTITUTE OF APPLIED PHYSICS  
AND COMPUTATIONAL MATHEMATICS in Chinese  
3 Jun 93 pp 15-18

[Article by Hu Side]

Our American friends are very concerned about China's nuclear policy and plan. Let me take this opportunity to introduce and analyze why China has to develop nuclear weapons, as well as China's view on nuclear disarmament.

I believe that you have read John Lewis's book "China Builds the Bomb." In his book, the author very objectively points out the fact that China was forced to develop nuclear weapons as a result of the unwise and flawed U.S. policy towards China. In a recently published authoritative book "Modern China's Defense Scientific and Technology Undertaking," it is summarized accurately as follows: "Since the founding of the new Chinese government, the U.S. government blackmailed and threatened China with atomic weapons. The war-torn country of China needed peace. Nevertheless, peace had to be defended with weapons. In order to break the monopoly of nuclear weapons held by imperialist countries, to defend itself and to maintain world peace, China has to get hold of cutting-edge defense technology as soon as possible. It needed to develop its own guided missile based nuclear weapons in order to possess an effective defensive nuclear deterrent."

In the late 50's, with the deterioration of relations with the USSR, China was determined to develop nuclear weapons of its own. This defensive nuclear strategy dictates China's extreme self-constraint attitude toward nuclear weapon development and nuclear testing. Since China detonated its first atomic bomb, the government immediately declared that "China's development of nuclear weapons is not based on the belief that nuclear weapons are invincible. On the contrary, China wants to break the nuclear monopoly in order to destroy nuclear weapons." We also announced that "China will not launch a first nuclear attack under any circumstances." Premier Chou Enlai suggested a meeting of all heads of nations to discuss a complete ban and destruction of nuclear weapons.

In the past 30 years, China has abided by this principle. A very limited nuclear force has been built with self-constraint. China built this nuclear force to merely stop nuclear superpowers from launching a nuclear attack on China. It has neither the intention nor the resources to be on equal footing with the U.S. and USSR. Based on SIPRI statistics, the number of warheads owned by China is only a few percent of those owned by the U.S. and Russia. In terms of nuclear testing, China has conducted less than 40 tests since 1964. On average, it is a little more than 1 test per year. The U.S. has conducted more than 940 tests, an average of approximately 20 per year. The number of nuclear tests conducted by China is maintained at the minimum level required to keep its strategic nuclear force effective.

A reflection of the history of nuclear power development in China also leads to a thought that whether the leaders in China would choose to build their own nuclear power had the U.S. government adopted an open, fair and wise China policy to allow its relation with China to develop in a friendly and healthy manner, instead of nuclear blackmail. Although this issue is water under the bridge, it should be inspiring to us. In recent years, Chinese leaders have repeatedly made known China's basic position with regard to nuclear disarmament. The key points can be summarized as follows:

1. The ultimate goal of nuclear disarmament is a CTB and total destruction of all nuclear weapons.
2. The U.S. and Russia should play a leading role in stopping production, deployment and testing of nuclear weapons and in reduction of nuclear weapons in order to create the condition for a worldwide nuclear disarmament meeting.
3. No nuclear country will launch a first strike and must not threaten non-nuclear countries with nuclear weapons.
4. Chinese leaders made repeated promises that China has no intention of avzzzzoiding its own obligation and responsibility.

These steps are the right way to save people all over the world from the threat of nuclear war. They play a significant role in pushing the current nuclear arms control activity forward.

China has long been a supporter of total nuclear disarmament and a CTB. In the area of nuclear testing, China has maintained a very conservative attitude. This view has a major effect on the implementation of a CTB. If all nuclear countries promise not to launch a first attack and not to use nuclear weapons in non-nuclear regions, trust among

nations and the sense of security can improve substantially. This can provide the political atmosphere necessary for a CTB. China is asking the U.S. and Russia to stop production, deployment and testing of nuclear weapons and to reduce their nuclear arsenals on a larger scale. This can effectively reduce the need for verification and remove obstacles in the implementation of CTB.

China has already done a lot in nuclear arms control. It has limited its nuclear force to the minimum size. The number of nuclear tests is limited to one per year. Although China is not a signatory of the partial nuclear test ban treaty, nevertheless, it unilaterally promised not to conduct atmospheric and underwater tests. Despite the fact that China believes that the NPT treaty is imperfect and discriminatory, based on its concern of international safety, it signed the NPT treaty. Even before signing the NPT treaty, China had adopted a non-proliferation policy that not only did not encourage nuclear proliferation but also prevented helping other countries develop nuclear weapons. China plays an active role in the Geneva disarmament committee. In particular, China unconditionally promises not to use nuclear weapons in a first attack. This is significant in establishing mutual trust between countries. We must stress that China's promise of not using nuclear weapons in any first attack is unconditional. It is not dependent upon a pre-requisite that other nuclear nations also abide by such a promise. As we make more progress in nuclear arms control, I believe that China will assume more obligations and responsibilities in arms control. Of course, it must first be based on security considerations and then dependent upon the nuclear arms control situation. It is also dependent upon the improvement of relations with other nuclear nations. The improvement of Sino-American relations in particular, will play a positive catalytic role. All our American friends present are looking forward to a friendly relationship between China and the U.S. Over the years, you have worked hard to build a bridge between the two peoples for better understanding. I sincerely hope that you use your influence to further improve the relation between our countries.

**Application and Study of Digital Multiplex/  
Demultiplex Technique in Remote Sensing  
Satellite System**

93FE0707A Beijing ZHONGGUO KONGJIAN KEXUE  
JISHU [CHINESE SPACE SCIENCE AND  
TECHNOLOGY] in Chinese Vol 13 No 2,  
25 Apr 93 pp 1-9

[Article by Yang Hongchiao [2799 7703 0829] and Fan  
Shiming [5400 1102 2494] of the Beijing Institute of  
Satellite Information Engineering]

[Abstract] The application of digital multiplex/  
demultiplex technique in a high data-rate satellite ground  
application system (Quick Look System) is discussed. It  
points out the importance of frame synchronization in  
maintaining normal operation of a receiving system and  
the need for sync protection to improve its stability and  
reliability. The conventional method of sync protection is  
described and mathematical formulas for estimating the  
average time interval between loss of frame sync and the  
average time of verifying loss of frame sync are presented.  
Several practical designs for implementing frame synchro-  
nization systems are discussed; specifically, the operations  
of open-loop and closed-loop frame synchronization sys-  
tems are illustrated, and the main components of the  
open-loop system which include the frame sync recognizer,  
the frame sync protector and state switching unit, and the  
serial signal divider are described. In addition, the concept  
of a parallel frame synchronization system designed for  
parallel-processing computer systems is proposed, and a  
formula for estimating the average sync acquisition time of  
this system is derived.

**Determination of Frequencies of Coupled In-Plane  
Vibrations of Tethered Satellite Systems**

93FE0707B Beijing ZHONGGUO KONGJIAN KEXUE  
JISHU [CHINESE SPACE SCIENCE AND  
TECHNOLOGY] in Chinese Vol 13 No 2,  
25 Apr 93 pp 15-22

[Article by Zhu Renzhang [2612 0088 3864] of the Beijing  
Institute of Spacecraft System Engineering]

[Abstract] A general method of determining the frequen-  
cies of vibrations of a N-body tethered satellite system is  
presented. Specifically, the N-body problem is trans-  
formed into a M-point boundary-value problem by  
dividing the tethered satellite into M-1 segments so that  
the tension on each segment can be considered as constant.  
The M-point problem is further reduced to an equivalent  
two-point boundary-value problem by making use of the  
boundary conditions at the intermediate junction points;  
as a consequence, the problem of determining coupled  
in-plane vibrations is reduced to one of evaluating a  
fourth-order determinant. By introducing the concept of  
the center of motion of a tethered satellite system, one can  
derive an expression for the average tension in each tether  
segment which can be used in determining the frequencies  
of system vibrations. Detailed expressions for the axial and  
lateral displacements within the orbit plane are derived by  
solving the partial differential equations of vibration with  
corresponding boundary equations. The frequency equa-  
tions of the original M-point problem and the equivalent  
two-point problem are presented and formulas for calcu-  
lating the tension in each tether segment are derived.  
Finally, a numerical example of frequency calculations for  
a simulated 4-body tethered satellite system is presented.

**Thermal Design of DQ-1 Balloon Satellite**

93FE0707C Beijing ZHONGGUO KONGJIAN KEXUE  
JISHU [CHINESE SPACE SCIENCE AND  
TECHNOLOGY] in Chinese Vol 13 No 2,  
25 Apr 93 pp 31-35

[Article by Xu Jiwan [1776 3444 5502], Jiang Jingshan  
[3068 4842 0810], Qian Shengyu [6929 4141 3842], and  
Zhang Shiling [1728 0013 3781] of the Beijing Institute of  
Spacecraft System Engineering]

[Abstract] The thermal design and thermal testing of a  
3-meter Chinese balloon satellite are presented. The  
unique thermal characteristics of a balloon satellite and the  
requirements for thermal design are described. Based on  
these characteristics, the application of passive thermal  
control method in thermal design is discussed. It is pointed  
out that the measured temperatures from thermal testing  
are in good agreement with the calculated data, and that  
the temperatures of the balloon satellite meet design  
requirements.

**Decoy System, Other Air-Defense Radar Breakthroughs Announced**

93P60296A Hefei ANHUI RIBAO in Chinese  
22 Jun 93 p 3

[Article by Jiang Deqing [1203 1795 3237] and Chen Ying [7115 5391]: "Ministry of Electronics Industry's Institute 38 Has New Breakthroughs in Research on Ground Air-Defense Radar Technology"]

[Summary] The Ministry of Electronics Industry's Institute 38 has made eight new breakthroughs in research on ground air-defense radar technology, including its recent development of a decoy system. Some of these achievements match mid-80s-to-early-90s international standards and therefore greatly raise the reliability and defensive potential of the nation's ground air-defense radar system.

Recognizing the four most critical threats to ground air-defense radar—anti-radiation missiles, stealth aircraft, integrated electronic jamming, and breakthroughs of defensive lines at radar blind zones—the former MMEI assigned the development of the decoy system and three other projects to Institute 38 over 2 years ago. Development of these four projects is now complete, and some achievements have been field-tested. The decoy system, designed to fool the enemy's anti-radiation missiles and therefore prevent the radar's destruction, is now being applied in low-airspace search radar units, and will be available on the international military electronics market. Other new ground air-defense radar products developed by Institute 38 include a distribution cabinet, technology demonstrator [jishu chongyan], card cage, and an information trunk unit [cha xian ji].

## Research on Nanoscale Direct Etching on Graphite Surface

93FE0753A Beijing KEXUE TONGBAO [CHINESE SCIENCE BULLETIN] in Chinese Vol 38 No 5, 1-15 Mar 93 pp 433-435

[Article by Wang Zhonghuai [3769 1813 2037], Dai Changchun [2071 7022 2504], Sun Hong [1327 4767], and Bai Chunli [4101 2504 4409, liaison person] of the Institute of Chemistry, Chinese Academy of Sciences, Beijing 100080: "Study of Nanoscale Direct Etching on Graphite Surface"; funded by the Natural Science Foundation of China and the Chinese Academy of Sciences; MS received 4 Sep 92, revised 15 Nov 92. Cf. brief report in JPRS-CST-92-017, 24 Sep 92 p 25]

[Text] The utilization of scanning tunneling microscope (STM) to nanoscale process the surface of a conductor or a semiconductor can theoretically further understanding of atom or molecule movement rules as well as basic research on mesoscopic physics, quantum mechanics, etc. This use also has the potential for application in areas such as manufacturing of high-density information storage components, nanoscale electronic components, etc. Recently, some progress has been accomplished in the field.<sup>1</sup> (Footnote 1) (Ma Zili, Shen Jian, Zhu Changxin et al., Proceedings of First National Conference on Nanoscale Science and Technology (in printing).) Using the institute's independently developed STM,<sup>2</sup> we directly etched different Chinese characters and designs on graphite surfaces by applying pulse voltage between the probe and the specimen.

### 1. Experimental Method

The experiment instrument is the independently made Model CSTM-9000 STM<sup>2</sup> operated in atmosphere. A computer controls the probe pulse voltage. The probe can be positioned precisely anywhere in the scanning area. The 0.25-mm-diameter probe is made of 80Pt-20Ir alloy by mechanical shearing. The base material is high-orientation cleaved graphite.

Graphite surface etching is processed in two steps: First the computer controls the probe in a tunneling state to move or to position along a predetermined path. At the specific location, the computer applies a pulse voltage between the probe and the specimen. Thus, physical and chemical reactions occur at the location to produce the mark. The second step is continuously moving the probe to etch a design on the graphite surface. In order to assure that there is no contact between the probe and the specimen during etching, the feed-back is not shut off.

Instead of using the experimental parameters of Albrecht et al.,<sup>1</sup> we adopted a 3-6 V pulse amplitude to write characters and etch designs. The pulse width is between a few tenths to ten-odd milliseconds. Constant-current mode is used throughout the experiment.

### 2. Results and Discussions

Figure 1 shows the structures of three predetermined etched locations formed by pulse voltage on the graphite surface. The structures of both bumps and cavities appear at each location. The scanning range is 82 nm x 97 nm. The similarities of the general structures of these three spots indicate that the probe shape affects the etched marking.

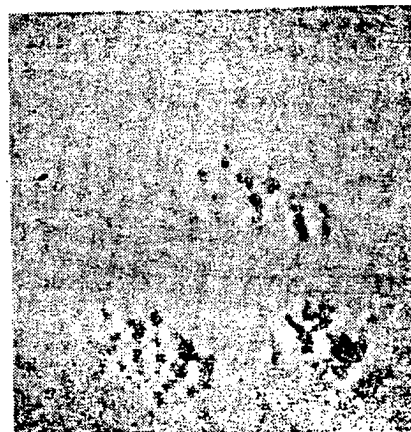


Figure 1. Pulse Voltages Are Applied on Three Defined Locations and Form Three Similar Rough Structures (scanning area: 82 nm x 97 nm)

Figure 2 shows the characters and designs with 10 nm line width which are control-etched by the computer software. Figure 2(a) shows the two characters "Zhong Guo," each character having a size of 200 nm x 200 nm. The scratch mark in Figure 2(a) is caused by the probe or the surface physical or chemical reactions while they are still in an unstable condition after etching. The graph generally becomes sharper after repeated operations. Figure 2(b) shows the English letters "CAS" (the abbreviation of Chinese Academy of Sciences). Each letter is the size of a 60 nm square. In Figure 2(b), it seems that the lines are formed by removing one or more layers of graphite atoms from the local region under the probe. It is also possible that lines are formed by chemical reactions which alter the electronic state.

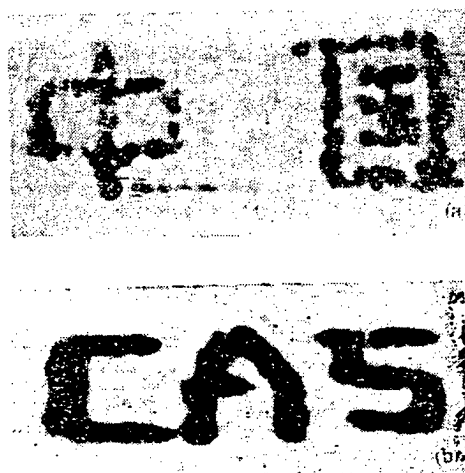


Figure 2. Characters and Designs With Line Width About 10 nm Etched With a Pulse Voltage Amplitude of About -4.5 V and Width of 8 ms. (a) The two etched characters "Zhong Guo," character size: 200 nm x 200 nm. (b) The English letters "CAS," letter size: 60 nm x 60 nm

The following phenomena in this experiment have been observed: (1) There is a threshold amplitude value (generally about -3 V) for the pulse voltage to produce an observable reaction between the probe and the specimen. This threshold value is related to the probe's condition (including its shape). In addition, the changing of the pulse width affects the test results more. The probe shape and the pulse width determine the line width. (2) After the completion of the etching process, the probe is still in good condition, and still reaches an atomic-level resolution. It is possible that the etching process actually further ameliorates the probe. (3) The surface graphite of the etched region becomes quite loose because of the laminated structure of high-orientation graphite. After a period of repeated scanings, the structure easily becomes random. This observation is the same as that of Albrecht et al.<sup>1</sup> (4) Probe condition (including its shape) crucially affects etching results. Under the same conditions, including base material, pulse (amplitude and width) and other experimental parameters as well as even probe material, the etching results are not necessarily the same. The experimental results show that bumps and cavities appear simultaneously. (5) The experiment encountered quite a few multi-probe effects.<sup>3</sup> We presume that the effect is shown by two features as follows: First, during etching, the multi-probes react and form many probe marks on the surface; and second, the etching marks have heavier undulations contributed by the multi-probes.

The STM has been used frequently for surface decoration, etching and writing; however, researchers differ on the explanations of its etching mechanism. Because experimental works are not sufficiently in depth, research on the mechanism is still inconclusive in many areas. The purpose of studying the mechanism is to produce lines and patterns that are more uniform, finer, and tolerant of repetitive etching. We believe that the possible mechanisms of graphite surface etching are as follows: (1) Due to long pulse time, and high local energy density, as well as the possibility of contamination of the probe in the atmosphere, sufficient energy is produced causing the deposition of probe contamination on the graphic surface. (2) Local high energy density probably can heat up the atoms in the local region and thus evaporates them.<sup>4</sup> Calculations<sup>1</sup> indicate that continuous pulse voltage can only increase surface temperature by no more than 5°C. However, the calculation is based on macroscopic observation, and it may be unsuitable for the STM's nanoscale operation. (3) The nanoscale beam current supplied by the STM probe induces some chemical reactions between the surface carbon or other atoms adsorbed from air, or even the surface substances. Consequently, these reactions produce a different topography or a change of the electronic state within the microscopic region under the probe. Since the STM image contains information on the electronic state and topography, the moving of the probe will display a mark on the STM image. As to the occurrence of bumps and cavities, our explanations are as follows: Because the graphite surface is fairly flat, the single atom at the tip of the probe contributes the most to the tunneling current for the formation of the atomic image. However, in etching, the probe provides a closed electric field; therefore, the reaction spot is not a single atom, but a nm area of the probe tip. The probe has a complicated form, and a

macroscopically very sharp tip is still very rough in nanoscale. Moreover, between the probe and the surface, there are many physical quantities, such as energy density, electrical field, beam current, etc., which are subject to the influence of the form of the probe tip. The material from the rough probe will deposit a similar mass of material on the surface. It is also possible that varying degrees of chemical reactions occur between the nm-scale region on the probe and the micro-region on the surface and thus evaporate the material at varying rates. Consequently, the complicated probe topography results in the complicated mark topography. Actually the topography of a mark is an indirect reflection of the probe.

### 3. Conclusions

Based on the experiments, we conclude:

- (1) It is possible to write or to etch designs on the graphite surface by computer control of a pulse of -3 to -6 V in amplitude and a few ms to ten-odd ms in width. The process is repeatable.
- (2) There is a threshold pulse voltage (about -3 V) to produce an observable reaction between the Pt/Ir probe and the graphite specimen.
- (3) In the etching experiment, the probe shape has a critical effect. The shape affects not only the threshold pulse voltage, but also the topography of the mark.

### Acknowledgment

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### Reports on Fabrication, Characterization of Nanoparticles

#### ZnO Nanocrystalline Sensitive Material

93P60293A Changchun JILIN DAXUE ZIRAN KEXUE XUEBAO [ACTA SCIENTIARUM NATURALIUM UNIVERSITATIS JILINENSIS] in Chinese No 2, May 93 pp 116-118

[Article by Zhang Lihua [1728 7787 5478], Wang Zichen [3769 1311 1820] et al. of the Dept. of Chemistry, Jilin University, Changchun 130023; "Preparation of Zinc-Oxide Nanocrystalline Sensitive Material"; MS received 4 Oct 92, supported by grant from NSFC]

[Abstract] Via a citrate method—domestically manufactured  $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  dissolved in citric acid and imported (from Japan) polyethylene glycol—nanoscale polycrystalline  $\text{ZnO}$  particles of diameter 20 nm, 26 nm, and 31 nm (processing at 450, 500, and 550°C, respectively) have been synthesized. Instruments used include a Shimadzu Corp. model XD-3A X-ray diffractometer, a Hitachi model H-800EM electro-optical TEM, a PE (U.S. company) model DTA 1700 differential thermal analyzer, and a Nicolet Instruments Corp. (U.S. firm) model 5 DX infrared absorption spectrometer. The effects of heating temperature and heating time in the course of crystallization are studied. The nanoparticles prepared are high-purity, uniform, spherical, cubic polycrystals.

Four figures, no tables.

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#### $\text{TiO}_2$ Ultrafine Particles

93P60293B Changchun JILIN DAXUE ZIRAN KEXUE XUEBAO [ACTA SCIENTIARUM NATURALIUM UNIVERSITATIS JILINENSIS] in Chinese No 2, May 93 pp 119-122

[Article by Bao Xinnu [7637 2450 0505], Zhang Yan [1728 1484], Xiao Liangzhi [5135 5328 6347], and Li Tiejun [2621 6993 3160] of the Dept. of Chemistry, Jilin University, Changchun 130023 (Xiao and Li also of the CCAST, World Lab, Beijing 100081), and Lai Zuyou [6351 4371 3731] and Gu Shiwei [7357 0013 3161] of the Dept. of Applied Physics and Institute of Condensed-Matter Physics, Shanghai Jiaotong University, Shanghai 200030: "Influence of Surface Coating on Optical Properties of  $\text{TiO}_2$  Ultrafine Particles"; MS received 22 Aug 92, supported by grant from NSFC]

[Abstract] A series of  $\text{TiO}_2$  ultrafine particles (UFPs) coated with a layer of oleic acid radicals have been synthesized. Preparation includes mixing titanium tetrachloride and sodium oleate in toluene, followed by a hydrolysis reaction to produce the oleic-acid-coated  $\text{TiO}_2$  UFPs, in which the toluene sol is yellow-orange or red. Instruments used include a Rigaku model D/MAX-RA 12 kW small-angle X-ray scatterometer and a Shimadzu model UV-365 spectrophotometer. It was found that the apparent optical band gap  $E_g$  decreases and the red shift of optical absorption band edge increases when the particle diameter  $d$  decreases. Table 1 gives the following values of diameter and apparent optical band gap for samples 1-5 (samples 1-3 are coated, samples 4-5 are uncoated), respectively: 3.68 nm, 2.84 eV; 3.55 nm, 2.71 eV; 3.30 nm, 2.41 eV; 4.36 nm, 3.69 eV; 2.93 nm, 3.74 eV. Table 2 shows that for particles of same  $d$  (3.55-3.56 nm),  $E_g$  for the oleic-acid-coated  $\text{TiO}_2$  UFPs is similar to that of stearic-acid-coated  $\text{TiO}_2$  UFPs (2.71 eV vs. 2.63 eV), but bigger than the  $E_g$  (2.46 eV) of  $\text{TiO}_2$  UFPs coated with dodecylbenzene sulfonic acid (DBS).

Two figures.

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### Test Drug Proved Effective for AIDS

40101017B Beijing CHINA DAILY (National)  
in English 5 Jul 93 p 3

[Article by staff reporter Li Zhuoyan]

[Text] An experimental drug that combines Western medicines with Chinese herbal remedies has been proclaimed by a panel of experts as being able to "efficiently delay the effects of the AIDS disease in HIV-infected people."

The appraisal committee in Jiangmen of Guangdong Province concluded last Friday that the medicine, named AAC, was able to increase the number of T lymphocytes (CD4) in people infected with the human immunodeficiency virus (HIV) and thereby improve their immunity functions.

The number of T lymphocytes, which maintain the body's immunity functions, will greatly decrease in HIV-infected people and thus lead to AIDS-related complications, which are usually the direct causes of death in AIDS cases.

Clinical trials of AAC have been carried out on 150 HIV-infected people in Yunnan Province, with noticeable benefit.

AAC was jointly developed by the Jiangmen Fine Chemicals Industrial Plant and the Beijing Academy of Military Medical Sciences.

The appraisal, organized by the Guangdong Committee of Science and Technology, was done by a panel led by Qian Xinzong, former State Minister of Public Health; Wu Dechang, President of the Beijing Academy of Military Medical Sciences; and Meng Zhaoke, a research fellow of the China Academy of Preventive Medicine.

"AAC is a successful combination of Chinese herbal medicines and the best Western medicines that can handle AIDS at present," Qian said.

According to experts at the appraisal, DTC is recognized as the sole medicine with any helpful effect on HIV-infected people.

AAC promises to perform at least as well as DTC, and without DTC's side effects on organs. An admixture of Chinese medicines helps AAC protect organs, especially of the digestive system.

Although China has only 900 of the world's 12 million HIV-infected people, Qian said, it is becoming increasingly urgent for the country to act because the threat of AIDS in Asia has become enormous.

For example, the estimated number of HIV-infected cases in India surpasses a million. And Thailand, another neighbour of China's, has become Asia's greatest victim of AIDS.

### Scientists Join World Genetic Research Pool

40101017A Beijing CHINA DAILY in English  
29 Jun 93 p 1

[Text] Chinese scientists hope to find genetic information that may lead to treatment of thousands of hereditary diseases as well as cancers and heart problems.

The National Natural Science Foundation of China has decided to join international efforts to study the human genome in order to analyse the total chromosome content of human genetic material, a foundation official told XINHUA.

By launching the "China human genome project," classified by the State as extremely important, the foundation hopes to obtain a complete data bank of genetic information which will help the early diagnosis and treatment of more than 5,000 hereditary diseases.

"The Chinese account for more than one fifth of the world's population, and the country has 56 ethnic groups," a foundation official told XINHUA. "Because of this, no one can claim to have established a complete data bank of human genetic information without a thorough study of the Chinese human genome," the official said.

The studies of the Chinese genome will focus on:

- The collection and preservation of the genomes of 10 Chinese ethnic groups.

- The development of new technology for the study of local mutations, large-scale separation of DNA fragments and the structure of genetic banks.

- The genes liable to cause diseases peculiar to China's ethnic groups.

### WHO Advocates Using Qinghaosu Derivatives for Malaria Treatment

93P60297B Beijing ZHONGGUO KEXUE BAO  
[CHINESE SCIENCE NEWS] in Chinese 19 May 93 p 3

[Article by Zhang Tiankan [1728 3944 0522]]

[Summary] According to the World Health Organization (WHO), the malaria epidemic is now spread over more than 100 nations with 270 million people being infected, and each year the disease incidence is expected to reach 110 million cases while more than 1 million people will die of malaria. Unlike most high incidence areas in the world, where Plasmodium falciparum are resistant to chloroquine, Plasmodium falciparum obtained from South China, Southeast Asia, South America, and Africa are resistant to sulfadimethoxine (SDM) and pyrimethamine. Since plasmodia are found to have gradually adapted to the chemically-synthesized drugs, the world is turning its attention to drugs derived from natural plants, such as Qinghaosu (arteannuin) and its derivatives—artether, artemether, artesunate—which were recently developed by Chinese researchers. Results from clinical trials conducted in China, the Netherlands, Vietnam, Nigeria, Kenya, and Papua New Guinea indicated that the malarial infection mortality went down from 20-30 percent to 10 percent when arteannuin and its derivatives were used instead of conventional drugs. The Development and Planning Agency of WHO and the World Bank have jointly advocated the further development of the three arteannuin derivatives.

**HFRS Vaccines Developed**

93P60297A Beijing YIYAO XINXI LUNTAN [CHINA MEDICAL TRIBUNE] in Chinese Vol 19 No 23, 17 Jun 93 p 1

[Article by Yu Yongxin [0205 3057 2450]]

[Summary] Two vaccines for controlling hemorrhagic fever renal syndrome (HFRS) have been developed by the Chinese researchers. An inactivated live vaccine obtained from gerbil kidney cells was jointly developed by the Zhejiang Epidemic Diseases Prevention Station, the Shanghai Institute of Biological Products, and the National Institute for the Control of Pharmaceutical and Biological Products. Researchers cultured a Z<sub>10</sub> strain of wild-rat type HFRS virus in gerbil kidney cells and inactivated the viruses with propiolactone. Results from four clinical trials conducted on 2,500 people indicate that the vaccine is safe and has a low reaction rate of 0.62 percent. Eighty-seven to 100 percent of the antibody was found in people receiving three consecutive injections, and 100 percent was reached followed by a booster injection with an antibody level two to three times higher. The other inactivated vaccine purified from mice brains was developed by the Lanzhou Institute of Biological Products. The LR<sub>1</sub> strain of wild-rat type HFRS virus was inoculated in the brain of suckling mice, purified, and inactivated with propiolactone. This vaccine is said to be more stable and effective than the first one. Antibody level produced by this vaccine reached 100 percent after three consecutive injections, and the booster injection also elevated the antibody level two to three times. For marketing, China is currently putting both vaccines into large-scale production.

**Studies on the Associative Diazotrophs in Rice Rhizosphere**

40091014A Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 33 No 2, Apr 93 pp 79-85

[English abstract of article by Hai Weili [3189 0251 0500], Wang Yaodong [3769 5069 2639], and You Chongbiao [1429 1504 2626] of the Institute for Application of Atomic Energy, CAAS, Beijing, and Zhou Huiling [0719 1979 3781] of the Institute of Microbiology, Academia Sinica, Beijing]

[Text] Three new strains of diazotrophs (strain A1601, A1701 and A1702) isolated from rice roots, which have never been reported before were found to possess significant nitrogen fixation activities determined by means of the acetylene reduction method, especially by rice root extracts induction. Their capability of nitrogen fixation were also confirmed by <sup>15</sup>N trace techniques.

The physiological and biochemical features of these associative nitrogen-fixers have been studied. As the results, strain A1601 is identified as *Alcaligenes paradoxus*, strain A1701 is identified as *Alcaligenes denitrificans* subsp. *xyloxydons* and A1702 as *Alcaligenes denitrificans* subsp. *denitrificans*.

**Coat Protein of Indian Cassava Mosaic Geminivirus—I. Primary Structures of Coat Protein and Its Gene**

40091014B Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 33 No 2, Apr 93 pp 98-103

[English abstract of article by Hong Yiguo [3163 4135 0948], Wang Xiaofeng [3769 1420 7685], and Tien Bo [3944 3134] of the Institute of Microbiology, Academia Sinica, Beijing, and D. J. Robinson and B. D. Harrison of the Scottish Crop Research Institute, Dundee, UK]

[Text] Geminivirus genomes have a conserved nine nucleotide sequence (5' TAATATTC 3') that was hypothesized to exist in ICMV. Assuming this hypothesis to be correct, cDNA was synthesized by utilizing the complementary sequence as a primer (5' GTAATATTA 3') and the main product was about 2.7 kb. cDNA molecules were cut with EcoRI, cloned in vector pUC19 which was used to transform DH5α competent cells. By colony hybridization, 39 recombinant plasmids were found. The sizes of inserts ranged from 0.15 kb to 2.5 kb as shown by EcoRI analysis. Coat protein gene was sequenced and translated into amino acid sequences by UWGCG software. Coat protein consisted of 256 residues belonging to 20 species of amino acids. Direct comparison of the coat protein of ICMV and with that of seven other whitefly-transmitted geminiviruses showed that the amino acid sequences of the N-terminal regions tended to be different, but the parts at the C-terminal were very similar.

Key words: Indian cassava mosaic geminivirus; Coat protein; DNA sequence

**Studies on the Multi-Copy *Streptomyces* Plasmid pIJ101—V. Two Copy-Number Mutants and Their Relationship With Cloned Fragments**

40091014C Beijing WEISHENGWU XUEBAO [ACTA MICROBIOLOGICA SINICA] in Chinese Vol 33 No 2, Apr 93 pp 104-107

[English abstract of article by Deng Zixin [6772 1311 2450] of Huazhong Agricultural University, Wuhan, T. Kieser and D. A. Hopwood of John Innes Institute, Norwich, England]

[Text] In the process of isolating and localizing the promoter-active regions, the BclI-E fragment of pIJ101 digested with MboI was ligated with BglII-digested pIJ425, a vector derived from the basic replicon of pIJ101. Among the thiostrepton-resistant transformants obtained after transformation of *S. lividans* TK64, two plasmids were found to have unusual copy-number. They were designated as pIJ2743 and pIJ2744. While pIJ2743 has an extremely high copy-number, about ten times of that of the vector pIJ425, pIJ2744 has low copy-number, about ten times lower than that of the vector pIJ425. Two extreme copy-numbers were maintained when the two plasmids were introduced into fresh TK64 protoplasts and were thus not caused by host mutations. Removal of the 0.63 kb insert from pIJ2743 and 0.68 kb insert from pIJ2744 gave plasmids with the same copy-number as the original vector pIJ425. This suggested that it is not the mutation(s) in the vector which caused the changes of the copy-number. For pIJ2743, proof that the cloned piece of DNA was actually

alone responsible for the increased copy-number came from subcloning the 0.63 kb BglII insert into the BamHI site of pIJ486, a vector similar to pIJ425. The extremely high copy-number was observed when the fragment was inserted in one orientation. With the same insert in the other orientation, a similar copy-number as for the vector without insert, pIJ425, was observed, suggesting that the effect of the insert might be cis-acting.

**The Expression of Hybrid Somatostatin-Hepatitis B Surface Antigen Particles With Recombinant Vaccinia Virus**

40091013A Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 25 No 2, Mar 93 pp 119-126

[English abstract of article by Xu Wenzhong [1776 2429 1813] and Du Nianxing [2629 1819 5281] of the Department of Veterinary Medicine, Nanjing Agricultural University, and Li Guangdi [2621 0342 0966], Zhu Nongliao [2612 3426 0055], and Wang Yuan [3769 0997] of Shanghai Institute of Biochemistry, Academia Sinica]

[Text] The synthesized somatostatin (ss, 14 aa) gene was fused with hepatitis B surface antigen gene (HBs gene) at the 3' end corresponding to amino acid residue 223. The fusion gene ss/HBs was then cloned into the transfer vector pGJP-5 under the control of P7.5 promoter. CV-1 cells were co-transfected with pGJP-ss/HBs and vaccinia virus (Tian Tan strain). TK<sup>-</sup> phenotype recombinant viruses were selected by plaque technique and identified by Southern blot and hybridization. The expression of ss and HBsAg was detected by dot-ELISA and RIA. The secreted ss/HBsAg hybrid particles as about 22 nm in size were seen under electron-microscope. It was suggested that the ss antigens were exposed on the surface of the hybrid particles.

Key words: Somatostatin; Hepatitis B surface antigen; Gene fusion; Recombinant vaccinia virus; Hybrid particles

**Prediction of Intron and Exon Sequence in Eukaryotic Gene by Neural Network Approach**

40091013B Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 25 No 2, Mar 93 pp 135-141

[English abstract of article by Cai Yudong [5591 3558 2639] of the Shanghai Institute of Metallurgy, Academia Sinica and Chen Changqing [7115 1603 1987] of the Shanghai Research Center of Biotechnology, Academia Sinica]

[Text] In this paper, a neural network method was applied to predict the splice site locations in eukaryotic gene. 90 human glycoprotein genes were selected as the training set to construct a network model and 27 human glycoprotein genes were used as the samples for prediction. Generally, the predicted splice sites were more than the true splice sites and only a very few nonconsensus splice sites could not be predicted. When the position of the start codon (ATG) and total amount of amino acids were known, the unique sequence of introns and exons could be obtained by computer from numerous possible combinations of predicted splice sites.

Key words: Neural Network; Eukaryote Gene; Intron-exon connection sites; Coding Sequence

**Studies on Expression of *Escherichia coli*  $\beta$ -Galactosidase Fusion Gene Under the Control of *Autographa californica* NPV p10 Promoter**

40091013C Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 25 No 2, Mar 93 pp 195-200

[English abstract of article by Long Qingxin [7893 4851 2450], Lin Guangyun [2651 1639 0061], et al. of the Institute of Entomology, Zhongshan University and National Laboratory of Biological Control, Guangzhou]

[Text] A transfer vector plasmid pQP10/gal containing a  $\beta$ -galactosidase gene of *Escherichia coli* in phase with the coding sequence of the *Autographa californica* nuclear polyhedrosis virus (AcNPV) p10 gene was constructed. The fusion gene was the inserted into the AcNPV genome by cotransfection of the transfer plasmid and wild-type AcNPV DNA. Infection of *Spodoptera frugiperda* cells by the resulting recombinant virus AcNPV-p10Z-9 showed high level expression of the p10-gal fusion gene, but no synthesis of p10 protein.

Key words: p10 gene; Recombinant baculovirus; p10-gal fusion protein

**Conformation Prediction and Comparison of Active Peptides From Lectins**

40091013D Shanghai SHENGWUHUAXUE YU SHENGWUWULI XUEBAO [ACTA BIOCHIMICA ET BIOPHYSICA SINICA] in Chinese Vol 25 No 2, Mar 93 pp 201-205

[English abstract of article by Wang Keyi [3769 0344 1138], Wang Sanshan [3769 0005 1472], and Liang Weiping [4731 5898 1627] of the Shanghai Institute of Biochemistry, Academia Sinica, 200031]

[Text] A nona peptide has been isolated from *Bauhinia purpurea* agglutinin (BPA). In the presence of calcium, this peptide could bind with galactose-Sepharose column (FEBS Lett. 1991, 281, 258). The secondary structure of this active peptide and related peptides from other lectins were predicted by Chou-Fasman method. The results showed that the propensities of these active peptides were to form a beta turn, and that the peptides before the active sites formed an alpha helix. It is interesting to note that the amino acid sequences of these peptides were homologous with those from some calcium-binding proteins (e.g. troponin and calmodulin).

The 3-D structure of concanavalin A was used as a model to calculate the conformation of active site from BPA by BIOGRAF software on SGI4D/20G graphics workstation. This active peptide looks like a letter C.

Key words: Lectins; Active site; Conformation prediction

**YF-II All-Digital Simulation Computer Developed by USTND Certified***93P60289B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 23 Jun 93 p 1*

[Article by Jia Xiping [6328 6007 1627] and Jia Yong [6328 3057]: "Galaxy All-Digital Simulator-II Computer Developed"]

[Summary] Changsha, 22 Jun (XINHUA)—Another major domestic high-tech breakthrough has been realized with today's certification of the Galaxy All-Digital Simulation-II (YF-II or YF2) computer, developed by scientists at the University of Science & Technology for National Defense (USTND, also known as Changsha Institute of Technology). This high-performance dynamic continuous systems simulator, which has applications in aerospace, weaponry, transportation, energy resources, chemical engineering, and other fields requiring real-time simulation, consists of a front-end unit, a multiple parallel processor, an integrated I/O system, and an integrated simulation environment. With an operating precision in the 65-bit-word floating point format, the YF-II has a simulation power 10 times that of the Galaxy Simulation-I (YF-I or YF1) computer, unveiled in 1985, and 5-50 times that of 10 MIPS general-purpose mainframe computer. The numerous advanced software systems are compatible with currently prevalent worldwide simulation languages. All technical indicators for the YF-II exceed those of comparable foreign-made simulators, and—with its good cost-performance ratio—this simulator should have excellent competitive power on the international market.

**YF-II All-Digital Simulator****Additional Details on YF-II Simulator***93P60289C Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 23 Jun 93 p 3*

[Article by Jia Yong [6328 3057]: "On the Unveiling of the 'Galaxy Simulation-II' Computer"]

[Summary] The YF-II's peak operating speed (with an operating precision in the 65-bit-word floating point format) has been measured at 66 MIPS, 10 times that of the YF-I simulator. In addition to the applications mentioned in the lead article, this high-performance simulator—whose development beginning in October 1989 has been described by the Central Military Commission as a "Vanguard Key S&T Project"—can be used in areas such as design of high-speed locomotives and automobiles and ultrasonic aircraft and in higher-reliability nuclear power plant data processing. YF-II software was developed by a 20-man team led by USTND Assoc. Prof. Dai Jinhai [2071 6855 3189], who with his

team translated over 1.6 million words in foreign documents and independently compiled over 3 million words of data. The team's "high-level simulation language compiling program" and five other major software programs occupy a total of 250,000 lines of code.

**Minister Promises New Age in Electronics***40100097A Beijing CHINA DAILY in English 3 Jul 93 p 2*

[Article by staff reporter Ren Kan]

[Text] The Ministry of Electronics Industry, re-established only last month, has vowed to lead the national economy into the information era.

Minister Hu Qili said yesterday in a national telephone conference that the industry would concentrate on three major projects: the Golden Bridge, the Golden Card and the Golden Custom.

The Golden Bridge refers to a national public information network connecting all ministries' and provinces' specialized data banks.

The Golden Card refers to the payment system for banks' credit cards.

The Golden Custom refers to an economic information network for foreign trade.

Completion of these three projects will accelerate China's entry into the information age while improving the country's macroeconomic control.

It will also open a new market for the industry, Hu said.

To enhance the electronics industry's role in the economy, it must make "serving customers" its priority.

The electronics industry is determined to become a pillar of the national economy and lead the modernization of the economy.

The industry has chosen computers and telecommunications as its key areas while giving priority to the development of integrated circuits and new electric components.

China's electronics industry has increased steadily this year.

During the first five months, the output of electronics products for industrial use jumped 54.68 per cent. Last year, output rose 47.4 per cent over the previous year.

The industry's annual production value is expected to rise 20 per cent, hitting 200 billion yuan (\$35 billion) in 1995.

The industry's output value last year was 100 billion yuan (\$17.5 billion).

#### **First Domestic Anti-EMW Polymer Film for Computer Screens Developed**

93P60289A Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 30 May 93 p 3

[Article by Shao Hui [6730 6540] and Zhi Fang [1807 5364]: "'Protection God' for Computer Operator Health: Domestically Pioneering Anti-Electromagnetic-Wave Polymer Film"]

[Summary] The anti-EMW polymer film developed by researchers organized by the Electronics Industry Design Commission in the Beijing Tongguang [6639 1639] Building has passed the efficiency testing conducted by the Ministry of Electronics Industry's Institute of Standardization and is patent pending at the State Patent Office. This film, when applied to the external surface of computer monitor glass screens, has been shown to reduce high-and-low frequency EMW radiation intensity by 70-90 percent, while transmitting 80 percent of the [useful] light.

**X-Ray-Laser Breakthrough: World Record GL of 17.5 Achieved***93P60291A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 8 Jun 93 p 1*

[Article by Wang Hanlin [3769 5060 2651]: "X-Ray Laser Research Achieves Breakthrough Advance"]

[Summary] Chinese X-ray laser scientists have realized another major breakthrough. Using their original four-target stack and the Shen Guang-I laser apparatus—with an output energy only 1/100 that of the U.S. facility—scientists at the China Academy of Engineering Physics' (CAEP) Shanghai Laser Plasma Institute and at the Beijing Institute of Applied Physics & Computational Mathematics are first in the world to obtain an effective gain-length product (GL) of 17.5 for deeply saturated laser radiation at two spectral lines (wavelengths of 23.2 and 23.6 nm) associated with Ne-like Ge ion transitions. The project, supported by the 863 Plan's Laser Technology Area, has potential application in 3D holography for revealing genetic structures.

**Flash-II Pulsed IREB Accelerator Certified***93P60294A Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 3 Jul 93 p 1*

[Article by Su Kuoshan [5685 2368 0810] and Jia Yong [6328 3057]: "Nation's Accelerator Research Enters World's Front Ranks: 'Flash-II' Passes State Appraisal the Other Day"; for technical details on Flash-II, see JPRS-CST-92-001, 30 Jan 92 pp 77-87]

[Summary] Xian, 2 Jul (XINHUA)—The "Flash-II" [Shan guang 7026 0342] low-energy pulsed intense relativistic electron beam (IREB) accelerator developed by Northwest Institute of Nuclear Technology passed formal State appraisal here the other day. This high-tech achievement propels the nation into the world's front ranks: China follows the United States and Russia in the development of this type of accelerator. The Flash-II has applications in simulating electromagnetic phenomena; in aerospace, energy, laser, and materials technologies; and in high-power microwave (HPM) defense research. This low-impedance IREB accelerator has a maximum current of 1 MA, power of 1 terawatt (TW), and pulse width under 100 ns. The Flash-II development project began 10 years ago, and the apparatus was first put into trial operation in 1990.

**SG-1 FEL, BFEL Certified; Asia's First IR-Spectrum FEL Light Generated***93P60291B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 8 Jun 93 p 1*

[Article by Wang Hanlin [3769 5060 2651]: "Major Breakthroughs in Free Electron Laser Technology Research"; see also JPRS-CST-92-006, 20 Mar 92 pp 53-54 and JPRS-CST-92-015, 29 Jul 92 pp 23-31]

[Summary] Beijing, 3 Jun—It has been learned from the Second National Annual Youth Academic Exchange on Laser Science & Technology convened today that two independently developed free electron lasers (FELs)—the

SG-1 FEL and the Beijing FEL (BFEL)—passed formal appraisal in April and on 26 May, 1993, respectively, and moreover that Asia's first IR-spectrum FEL light has been generated. The SG-1 FEL at CAEP has an output power of 10 GW, a power exponential gain of 20 db/m, and frequency of 34 GHz, and was appraised to meet mid-eighties international standards. The BFEL at the CAS Institute of High-Energy Physics is the nation's first IR-spectrum FEL to generate IR excited laser radiation, and the first of almost 10 IR FELs in Asia to accomplish this task.

**Electron Beam, Radiation Synchronization in Cavity of Beijing Free Electron Laser***40100099A Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 13 No 5, May 93 pp 435-438*

[English abstract of article by Wang Mingchang, Zhou Huifen, Feng Chengshi, Lu Zaitong, Zhang Lifan, and Wang Zhijiang of the Shanghai Institute of Optics and Fine Mechanics, CAS, Shanghai 201800; MS received 7 Mar 92, supported by grant from State 863 Plan, Laser Area]

[Text] The electron beam and radiation synchronization in the cavity of the Beijing free electron laser (BFEL) has been investigated. This is important to the design of the laser cavity. The effect of Brewster window inside the cavity on the radiation trajectory is discussed. A fine adjustment device driven by a personal computer is developed; the cavity axis can be moved by the device in the range of  $\pm 30$  mm with a resolution of 1  $\mu\text{m}$ .

**Table 1. The Parameters of Beijing Free Electron Laser**

| RF-Accelerator                                |                                       |
|---|---------------------------------------|
| Beam energy                                   | $E = 10\text{-}30$ MeV                |
| Peak current                                  | $I = 10\text{-}20$ A                  |
| Minimum beam diam.                            | $D_e = 1\text{-}2$ mm                 |
| Beam spread                                   | $\Delta\gamma/\gamma = 0.5\%$         |
| Emittance                                     | $\epsilon_N < 30$ $\pi\text{mm mrad}$ |
| Macropulse width                              | $T_{\text{macro}} = 4$ $\mu\text{s}$  |
| Micropulse width                              | $T_{\text{micro}} = 4$ ps             |
| Microwave frequency                           | $\nu_{\text{RF}} = 2856$ MHz          |
| Wiggler period                                | $\lambda_w = 3$ cm                    |
| Number of periods                             | $N = 50$                              |
| Intensity                                     | $B_w = 3$ KG                          |
| Optical cavity wavelength                     | $\lambda_s = 10.6$ $\mu\text{m}$      |
| Length of cavity                              | $L_c = 251.923$ cm                    |
| Waist   | $D_r = 2.78$ mm                       |
| Diam. on mirror                               | $D_1 = D_2 = 6.7$ mm                  |
| Radius of curvature                           | $R_1 = R_2 = 1522.2$ mm               |
| Rayleigh length                               | $L_r = 575.1$ mm                      |
| Absorption index of ZnSe at 106 $\mu\text{m}$ | $a = 1.2 \times 10^{-3}/\text{cm}$    |

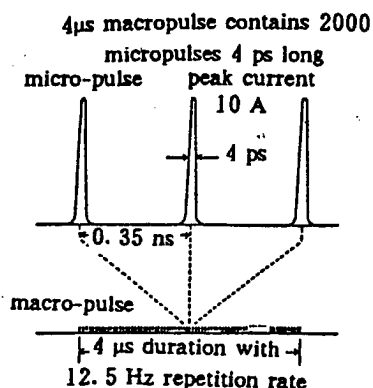


Fig. 1 Schematic diagram illustrating the 4  $\mu$ s, 0.35 ns and 4 ps time intervals

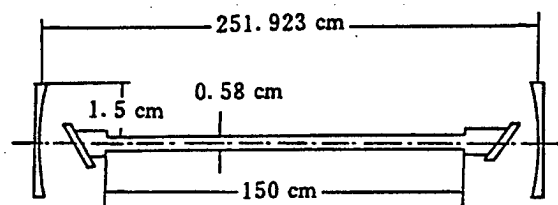


Fig. 2 Schematic of the BFEL optical cavity

### Nation's First Photon STM Certified

93P60291C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Jun 93 p 1

[Article by Han Weiyang [7281 4850 7122]: "Photon Scanning Tunneling Microscope Developed"]

[Summary] The nation's first photon scanning tunneling microscope (STM), jointly developed by scientists at the CAS Beijing Electron Microscope Laboratory and Dalian University of Technology, passed formal appraisal a few days ago. This new optical STM has a resolution of 10 nm and a scan range of 10  $\mu$ m x 10  $\mu$ m. The appraisal experts have certified the new instrument's main technical performance indicators as matching the worldwide state-of-the-art.

### First Domestic High-Resolution Intelligent SEM Certified

93P60291D Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 22 Jun 93 p 3

[Unattributed article: "High-Resolution Intelligent Scanning Electron Microscope Certified"]

[Summary] The nation's first independently designed and constructed high-resolution intelligent scanning electron

microscope (SEM) was certified the other day in Shanghai. The DXS-4 intelligent SEM has a resolution of 4 nm and a magnifying power of 200,000. Applications include research, production, and treatment in fields such as biomedicine, materials analysis, physics, and chemistry.

### Study on Propagation Matrix Method of Electromagnetic Waves and Transmission Properties in Stratified Chiral Media

40100096A Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 15 No 3, May 93 pp 287-293

[English abstract of article by Yin Wenyan and Wan Wei of Northwestern Polytechnical University, Xi'an 710072; MS received 9 Dec 91, revised 26 Aug 92]

[Text] The propagation matrix method of electromagnetic waves in stratified chiral media is introduced for the first time, and the general expressions of propagation matrix are derived. The reflection and transmission properties of electromagnetic waves at different chiral interfaces, single-layer chiral medium slab as well as air-chiral medium on metal substrate are analyzed, in which the effects of chirality admittance are especially considered.

### A Novel Universal Preprocessing Approach for High-Resolution Direction-of-Arrival Estimation

40100096B Beijing DIANZI KEXUE XUEKAN [JOURNAL OF ELECTRONICS] in Chinese Vol 15 No 3, May 93 pp 305-309

[English abstract of article by Wen Renbiao of Xidian University, Xi'an 710071; MS received 30 Dec 91, revised 8 May 92]

[Text] A new universal preprocessing method is proposed to estimate angles of arrival with high resolution, which is applicable to one- or two-dimensional high resolution processing based on arbitrary center-symmetric arrays (such as uniform linear arrays, equal-spaced rectangular planar arrays and symmetric circular arrays). By mapping the complex signal space into the real one, the new method can effectively off-load computational amount needed in the signal subspace high resolution direction finding techniques without any performance degradation. In addition, the new preprocessing scheme itself can decorrelate the coherent signals received by the array. For regular array geometry such as uniform linear arrays and equal-spaced rectangular planar arrays, the popular spatial smoothing preprocessing technique can be combined with the novel approach to improve the decorrelation ability. Simulation results confirm the above conclusions.

### A High-Stability, Ultra-Micromotion Constant-Velocity Piezoelectric Motor

40100095A Beijing YIQI YIBIAO XUEBAO [CHINESE JOURNAL OF SCIENTIFIC INSTRUMENT] in Chinese Vol 14 No 2, May 93 pp 120-126

[English abstract of article by Lu Boyin, Qu Xinghua, and Guo Jingbin of the Dept. of Precision Instrument, Tianjin University; MS received Dec 91, supported by grant from NSFC]

[Text] Some ultra-precision measuring, fine fabrication require scanning and position-control and indexing of a carriage to within nanometer accuracy over range of 50 mm or more, ultra-micromotion at nm level, and velocity of more than 1 mm/sec. A "constant-velocity piezoelectric motor" (CVPM) has been designed and constructed. It consists of two groups of clamps and two groups of actuators, which use bimorphs. By means of the method of relay motion "push-pull" alternately, and adopting closed-loop control to compensate nonlinear kinematic error, continuous linear micromotion has been achieved.

The constant-velocity piezoelectric motor can scan image acquisition size of more than 50 mm at nanometer level and is required to be compact and vacuum-compatible so that it can be used with electron microscopes or tunneling microscopes, diffraction-grating ruling, interference spectrometer scanning and wide-field astronomical starplate analysis.

In order to smoothly drive the position of the molecular measuring machine's carriage, whose motion is continuous, it is monitored via a laser interferometer and the power used is sent to a computer supply device.

This paper describes the principle of continuous micromotion, the structure character, the bimorph design, and the calculation of efficiency of the CVPM.

### Study of Two-Dimensional Quadratic Associative Memory System

40100095B Beijing YIQI YIBIAO XUEBAO [CHINESE JOURNAL OF SCIENTIFIC INSTRUMENT] in Chinese Vol 14 No 2, May 93 pp 167-173

[English abstract of article by Yan Yingbai, Wen Zhiqing, and Jin Guofan of Qinghua University; MS received Feb 92, supported by grant from NSFC]

[Text] On the basis of Hopfield neural network model, a programmable two-dimensional quadratic associative memory system is studied. A liquid-crystal electro-optical switch is used as a real-time input device, and a liquid-crystal TV (LCTV) is used to display the weight matrices.

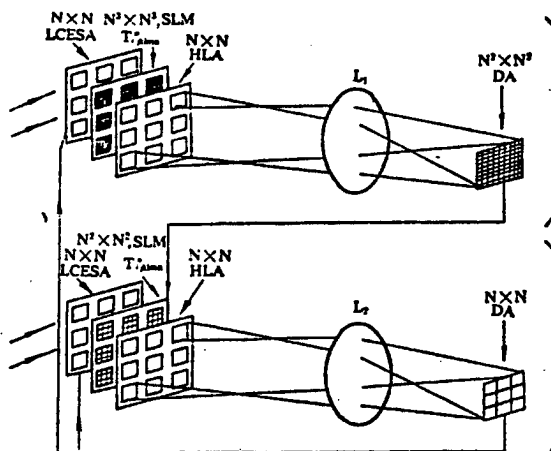


Figure 2. Schematic of Entire System; LCESA = liquid-crystal electro-optical switching array, DA = detector array.

The three-dimensional interconnections are realized by using a DCG holographic lenslet array (HLA). A new time-division processing method is proposed, which simplifies the system and gives a way to use a spatial light modulator (SLM) of relatively lower resolution for implementation of neural network containing higher quantity of neurons. The experimental results are presented to demonstrate its feasibility.

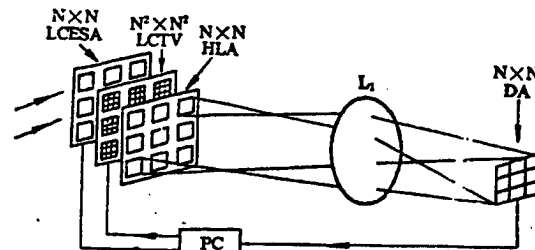


Figure 3. Time-Division Processing Method for System

### Bi-Coil Optical Fiber Bundle Displacement Sensor

40100095C Beijing YIQI YIBIAO XUEBAO [CHINESE JOURNAL OF SCIENTIFIC INSTRUMENT] in Chinese Vol 14 No 2, May 93 pp 184-188

[English abstract of article by Wang Qisheng and Chen Jianyuan of Southeast University, Nanjing; MS received Feb 92]

[Text] A new type of bi-coil optical-fibre displacement sensor is introduced. Its structure, working principle, experimental results and characteristics are also stated. This kind of sensor can eliminate the influence of reflectivity variation and light-source instability, enhance the measuring accuracy and widen the range of application.

### Comparative Pressure Leak-Detection Method Using Fiber Optic Sensor Technique

40100095D Beijing YIQI YIBIAO XUEBAO [CHINESE JOURNAL OF SCIENTIFIC INSTRUMENT] in Chinese Vol 14 No 2, May 93 pp 189-194

[English abstract of article by Sun Xiaohan, Zhang Mingde, and Wan Suiren of Southeast University; MS received Feb 92]

[Text] A new method of comparative leak-detection under pressure with fiber-optic sensor is advanced and studied. The expressions for differential pressure, detection time and minimal leak rate detected are derived by means of the study of pressure as a function of time in the device detected under pressure. The fiber-optic differential pressure sensor is presented and designed to high sensitivity and stability. Minimal value  $3 \times 10^{-5}$  of relative differential pressure detected is obtained. Finally, an example of the method used in industrial production is given.

### Monolithic Reactive Ion Etched Groove-Coupled-Cavity AlGaAs/GaAs Laser

40100101a Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol A20 No 3, Mar 93 pp 161-165

[English abstract of article by Zhang Shiqiao, Institute of Lasers, Taiyuan University of Technology, Taiyuan



030024; Tan Shuming, Department of Physics, Northern Jiaotong University, Beijing 100083; Zhang Wanru, Yang Peisheng, and Chen Jiying, National Laboratory of Integrated Optoelectronics, Institute of Semiconductors, CAS, Beijing 100083. MS received 12 Dec 91, revised Mar 92.]

[Text] Monolithic groove-coupled-cavity AlGaAs/GaAs lasers were fabricated by reactive ion etching of laser facets. CW stable single-mode operation at room temperature was observed. Typical single-mode FWHM is about 0.23 nm, mode suppression is 19 dB, mode spacing is 2.5 nm, and two-cavity threshold current for single-mode operation is 52 mA.

### Experimental Study of Polarization-Diversity Receiver for Coherent Optical Fiber Communication

40100101b Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol A20 No 3, Mar 93 pp 183-186

[English abstract of article by Shi Qing, Xu Anshi, and Xie Linzhen, The National Laboratory on Local Area Optical Fiber Communication Network & Coherent Optical Fiber Communication, Dept. of Radio-Electronics, Beijing University, Beijing 100871. MS received 4 Nov 91, revised 10 Jul 92.]

[Text] The principle of polarization-diversity receiver for coherent optical fiber communication is briefly discussed, and a polarization-insensitive receiver on the basis of polarization diversity is achieved for the first time in China. Good demodulated signals independent of polarization are obtained at 137.2 MHz and 146.0 MHz of sinusoidal-wave. This method is being applied to a 140 Mbit/s FSK coherent fiber communication system at 1.5  $\mu\text{m}$ .

### High-Efficiency Organic Nonlinear Crystal MHBA, Its Second Harmonic Generation

40100101c Shanghai ZHONGGUO JIGUANG [CHINESE JOURNAL OF LASERS] in Chinese Vol A20 No 3, Mar 93 pp 194-197

[English abstract of article by Zhang Nan, Yuan Duorong, et al, Institute of Crystal Materials, Shandong University, Jinan 250100. MS received 18 Nov 91, revised 28 Feb 92]

[Text] Phase-matched second harmonic generations in a novel organic material, MHBA [ $\text{C}_8\text{H}_8\text{O}_3$ ], have been obtained. The high conversion efficiency of 58.94% for  $1.06\mu\text{m} \rightarrow 0.532\mu\text{m}$  (Q-switched Nd:YAG laser) in an organic crystal is realized for the first time. Moreover, we have observed strong blue-violet light output, the tunable wavelength of which is 400 nm-450 nm. Conversion efficiency of about 6% for  $0.83\mu\text{m} \rightarrow 0.415\mu\text{m}$  has been obtained.

### Optical Implementation of Bipolar Directional Associative Memory

93FE0709B Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 13 No 4, Apr 93 pp 335-339

[Article by Wang Xuming [3769 6079 2494], Wang Jian-shui [3769 0256 3055], and Mu Guoguang [3018 0948

0342] of the Institute of Modern Optics, Nankai University, Tianjin: "Optical Implementation of Bipolar Directional Associative Memory"; MS received 13 Apr 92, revised 7 Jul 92, supported by the National Natural Science Foundation]

### [Text] Abstract

A general approach to implement bipolar neural network with linear discrete neurons in a single-channel optical vector-matrix multiplier by introducing an additional neuron as the background is presented. Modifications of the optical system and coding of the non-negative mask are given. Results of computer simulation and optoelectronic experiment conducted using a bipolar-neuron-based bidirectional associative memory are provided.

### 1. Introduction

The high degree of parallel processing of optical computing offers a feasible way to implement the hardware for a neural network. Although an optical field can be expressed in complex numbers, because of limitations imposed by detection methods, environmental impacts and stability in use, it is difficult to implement bipolar values optically. Since all existing optical neural networks are based on light intensity operations, in order to express the interconnection weights in the bipolar format, one approach is to process the positive and negative parts of the interconnection matrix in separate channels. The results are subtracted either optically or electronically.<sup>1,2</sup> Another approach is to provide a bias to the interconnection weight to form a non-negative interconnection weight.<sup>3</sup> By doing so, it is necessary to have a dynamic threshold based on the expected value of the associative output. Since the beginning of optical neural networks, most optical systems have employed unipolar neurons with bipolar interconnection weight states, i.e., using a non-negative input stimulus such as (0, 1). The use of a bipolar neuron state, such as using (-1, +1) to represent the input stimulus, can significantly enhance the interconnection capability of the optical system as compared to using a unipolar neuron state.<sup>4</sup> It is especially apparent when the distribution of 0 and 1 stored pattern is not uniform.<sup>5</sup> The study of bipolar optical networks, including the bipolar neuron state and bipolar interconnection weight, has attracted considerable attention.<sup>5-7</sup> The importance of the bipolar neuron state for improving network behavior has been stressed.<sup>5</sup> Algorithms that employ unipolar data to complete the expected function of a bipolar network have been presented.<sup>6,7</sup> As for the optical implementation, only reference 7 provides an experimental demonstration. With the aid of a liquid-crystal light valve spatial modulator, the bipolar neuron states are expressed by means of optical polarization. A bipolar three-layer optical network has been implemented through the use of interconnected positive and negative holograms. In our recent papers,<sup>8,9</sup> we proposed an interconnection mask coding method and an interconnection holographic recording scheme to implement a one-dimensional and a two-dimensional bipolar optical neural network separately in the same channel. This method requires only one interconnection element and also maintains the simplicity of the original unipolar neural network. This paper provides a more expanded form of the scheme for the optical implementation of a generalized linear discrete neural network. In addition,

results of computer simulation and optical experiment of a bipolar bidirectional associative memory are presented.

## 2. Unipolar Treatment of Generalized Bipolar Neural Network

The dynamic evolution process of a generalized discrete bipolar neural network can be expressed as follows:

$$S_i(t+1) = f\left[\sum_{j=1}^N T_{ij} S_j(t) - \theta_i\right], \quad (1)$$

Here,  $f[\ ]$  represents a non-linear threshold treatment involving a step function or an S function whose value ranges between -1 and +1,  $\theta_i$  is the bias threshold of the  $i$ th neuron,  $T_{ij}$  is the interconnection weight between the  $i$ th and  $j$ th neurons that may be an arbitrary real number,  $S_i(t+1)$  and  $S_i(t)$  represent the states of the  $i$ th neuron at time interval  $t+1$  and  $t$ , respectively, with values between -1 and +1, and  $N$  is the number of neurons. From here on,  $i$  and  $j$  represent 1, 2, ...,  $N$ . Let us define

$$V_i(t) = 1/2[1 + S_i(t)], \quad (2)$$

Let us further introduce two positive constants,  $A$  and  $Max$ , so that

$$W_{ij} = T_{ij} + A \quad (3)$$

$$D_i = Max - \frac{1}{2}\left(\sum_{j=1}^N T_{ij} + \theta_i\right) \quad (4)$$

become non-negative terms. Then equation (1) that describes the dynamic evolution of the bipolar neural network is equivalent to

$$V_i(t+1) = g\left[\sum_{j=1}^N W_{ij} V_j(t) - A \sum_{j=1}^N V_j(t) + D_i - Max\right], \quad (5)$$

$$g[x] = \frac{1}{2} + \frac{1}{2}f[2x]. \quad (6)$$

As we can see,  $V(t)$  is the input vector used by a unipolar neural network and  $g[x]$  is the corresponding form of the unipolar neural network. If an additional neuron is introduced which is defined as a constantly "excited" neuron stimulated by the input, and correspondingly an additional constant element  $V_{N+1} = 1$  is added to the input vector, then

$$V_i(t+1) = g\left[\sum_{j=1}^{N+1} W_{ij} V_j(t) - \sum_{j=1}^{N+1} W_{N+1,j} V_j(t)\right], \quad (7)$$

Here, a number of enlarged elements, i.e., the additional neuron and its interconnection weights with respect to other neurons, are defined for the non-negative interconnection matrix as follows:

$$W_{i,N+1} = D_i, \quad W_{N+1,j} = A, \quad W_{N+1,N+1} = Max. \quad (8)$$

These elements are non-negative. Since  $V_{N+1} = 1$ , equation (8) represents the distribution of the expected value of the added neuron. From equation (7), the result of a bipolar neural network can be obtained from the result of certain operations of a suitable unipolar neural network. By providing a constant input stimulation to the additional  $N+1$ th neuron and using its expected output as the threshold for other neurons, then the result corresponding to this threshold is that of the output of the corresponding bipolar neural network. If  $V_{N+1}$  is set to be 0, then the result is that of the corresponding unipolar neural network.

In terms of its optical implementation, only a slight modification of the optical configuration of the vector-matrix multiplier of the original unipolar network is required. As shown in Figure 1, in the original single-channel vector-matrix multiplier, it is necessary to add an additional input vector dimension, an additional row and an additional column in the interconnection matrix, and an additional output detector element. The output of this added detector is used as a reference, such as the comparison voltage or operating bias, for a threshold circuit or an optical threshold device.

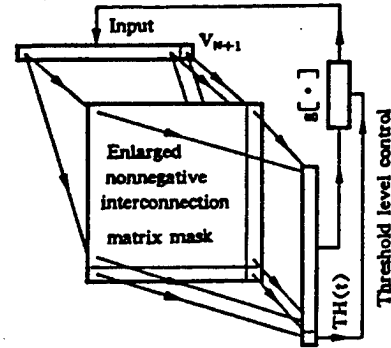


Figure 1. Optical Configuration for the Implementation of a Bipolar Neural Network in a Vector-Matrix Multiplier  $V_{N+1}$  Represents the Additional Input Dimension, and the  $(N+1)$ th Expected Output,  $TH(t)$ , Serves as the Dynamic Threshold Level

## 3. Bipolar Bidirectional Associative Memory

A bidirectional associative memory<sup>10</sup> can perform associative search in the "stimulus-response" mode. The interconnection matrix is the sum of the outer product of the "stimulus-response" pairs. When the initial input is similar to a "stimulus," the product of this input vector and the interconnection matrix provides an output that is similar to the corresponding "response." This threshold output is fed backward to the transformation matrix between the system and the interconnection matrix to produce a product. This output is going to be even more similar to the "stimulus." After repeated forward and backward iterations, the system will stabilize at that particular "stimulus-response" pair. A reflexive associative memory<sup>11,12</sup> and a bidirectional associative memory perform the same function in a different way. The difference is that the interconnection weight of the reflexive associative memory is the sum of that of the bidirectional associative memory and its transformation matrix. It

requires that the "stimulus" and "response" should be of the same dimension. A neural network comprised of such an interconnection matrix is a unidirectional feedback network. If a reflexive associative model employs a bipolar input scheme, then the unipolar conversion treatment described above is also suitable. In the iterative process, the output results from odd and even number of iterations correspond to "stimulus" and "response," respectively.

Let us assume that there are  $M$  binary (0,1) stored pattern pairs,  $(U^m, V^m)$ , where  $m = 1, 2, \dots, M$ . Based on the reflexive associative model, the interconnection weight is

$$T_{ij} = \sum_{m=1}^M [(2U_i^m - 1)(2V_j^m - 1) + (2U_j^m - 1)] - 2M\delta_{ij}, \quad (9)$$

Here,  $\delta_{ij}$  is the Kronecker  $\delta$  function. After going through the transformation shown in equations (1)-(8), the dynamic evolution of the network is still expressed by equation (7). The initial stimulus input may be one of  $U^m$  or  $V^m$  or its partial form.

#### 4. Computer Simulation and Optical Experiment

We chose a step function as a nonlinear threshold function, i.e.,

$$g(x) = \begin{cases} 1, & x \geq 0 \\ 0, & \text{elsewhere} \end{cases} \quad (10)$$

and selected two 25-dimensional vector storage pairs:

$$\begin{aligned} U^1 &= (1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, \\ &\quad 0, 0, 1, 1, 1, 1, 1) \\ V^1 &= (0, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, \\ &\quad 0, 0, 1, 0, 1, 0) \\ U^2 &= (0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, 0, 0, 0, 1, 0, \\ &\quad 0, 0, 0, 1, 1, 1, 1) \\ V^2 &= (1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 1, 0, 0, 0, 1, 0, \\ &\quad 1, 0, 1, 0, 0, 0, 1) \end{aligned}$$

to perform computer simulation and optical experiment. This is the vector configuration of four 5 x 5 dot-matrix letters I, H, L and X. Its interconnection matrix is determined from equation (9). Let  $A = 4$  and a non-negative interconnection matrix be created based on equation (3). With  $\theta_i = 0$  and  $\text{Max} = 9$ ,  $D_i$  becomes the following from equation (4):

$$D = (9, 10, 4, 5, 9, 3, 14, 4, 5, 3, 3, 5, 10, 0, 3, 3, \\ 14, 4, 5, 8, 9, 10, 9, 10, 18)$$

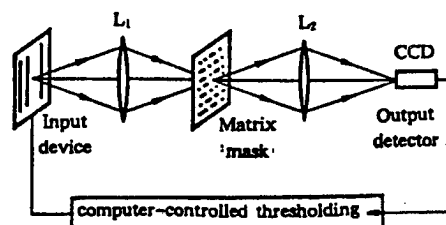
A 26 x 26 enlarged interconnection matrix is created based on the rules stated in equation (8).

Table 1 shows the computer simulation results. The first column represents the Hamming distance of the initial input vector from the stored patterns. This distance is obtained by turning the elements of that particular pattern. The numbers in the table are the serial numbers of the stored patterns corresponding to the accurate stable output patterns. F represents a false stored pattern or an erroneous oscillation. Since the complementary pattern is also a steady state of the network, the negative sign represents a complementary pattern pair.

**Table 1. Experimental Results for the Bipolar Bidirectional Associative Memory**

| Hamming distance of the input stimulus from $U^m$ or $V^m$ | Results of computer simulations and (optical demonstrations) |        |        |        |
|--|--|--------|--------|--------|
|  | $U^1$  | $V^1$  | $U^2$  | $V^2$  |
| 0-7  | 1(1)   | 1(1)   | 2(2)   | 2(2)   |
| 8  | F(F)   | 1(1)   | 1(1)   | 2(2)   |
| 9  | F(F)   | 1(1)   | 1(1)   | F(F)   |
| 10   | F(F)   | 1(F)   | 1(F)   | 1(1)   |
| 11   | F(F)   | -2(F)  | 1(F)   | 1(F)   |
| 12   | 2(F)   | -2(F)  | 1(F)   | 1(F)   |
| 13   | 1(F)   | -2(F)  | 1(F)   | F(F)   |
| 14   | 1(F)   | 1(F)   | 1(F)   | F(F)   |
| 15-16  | F(F)   | F(F)   | F(F)   | F(F)   |
| 17-18  | -1(F)  | F(F)   | F(F)   | F(F)   |
| 19   | -1(-1)   | F(F)   | F(F)   | F(F)   |
| 20   | -1(-1)   | F(F)   | -2(-2) | F(F)   |
| 21   | -1(-1)   | -1(-1) | -2(-2) | F(F)   |
| 22-25  | -1(-1)   | -1(-1) | -2(-2) | -2(-2) |

The optical demonstration was done on an equivalent vector-matrix multiplier, whose optical configuration is shown in Figure 2. The input vector with the additional element is displayed on the screen. It is projected onto the matrix mask using the imaging lens  $L_1$ . The transmitted optical field forms an image on the target plane of the CCD device through the use of  $L_2$ . The effect of the threshold on the output is compared with a computer in order to control the content displayed on the screen as the iteration process proceeds. This kind of optical configuration can be made by integrating the input screen, matrix mask and detector into direct contact.<sup>13</sup> The results of this optical demonstration are listed in parentheses in Table 1, for ease of



**Figure 2. Schematic Drawing of the Optical System Used for Optical Experiments.  $L_1$  and  $L_2$  are imaging lenses.**

comparison with the computer simulation results.  $F$  represents a false stored pattern, an erroneous oscillation or an unstable output.

One can see that when the Hamming distance is no greater than 7, the network can accurately perform pattern recognition. The results of optical experiments essentially agree with those of computer simulation. Small distortion of the imaging system and nonuniform illumination did not have much effect on the results. As a comparison, when unipolar neuron states are used, i.e.,  $V_{N+1} = 0$ , accurate associative output of the pattern selected can happen only with a Hamming distance no greater than 1. This proves that a bipolar network is better than a unipolar network in any circumstance.

### 5. Conclusions

This paper provides a generalized way to implement a bipolar neural network in a single vector-matrix multiplier channel and presents optical demonstration results of a single-layer neural network as a bipolar, bidirectional associative memory. This optical implementation scheme is suitable for all neural networks whose evolution can be expressed by equation (1). It is not necessary to use  $V(t+1)$  as a feedback in the iteration. The output of a neuron layer of a multi-layer feed-forward network can be used as the input stimulus for the next neuron layer. In this case, vectors  $V(t)$  and  $V(t+1)$  can be of different dimensions. The generalized bipolar optical neural network described in this paper, in principle, is suited for any linear discrete neural network. When the stored patterns are  $N_1 \times N_2$  optical images, we can perform vector configuration pretreatment for the stored images. If the optical images are to be stored in their original form, this involves the interconnection tensor issue which can be recorded with a hologram. Correspondingly, added holes of the patterns can be used to represent the additional neuron and recording background distribution.

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### Photon-Gated Spectral Hole Burning on Inorganic Material $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$

93FE0709A Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 13 No 4, Apr 93 pp 305-310

[Article by Zhao Youyuan [6392 2589 3293], Chen Lingbing [7115 0407 0393], Wang Guoyi [3769 0948 4135], Peng Yulian [1756 3768 5571], Qian Hongsheng [6929 4767 5116], and Li Fuming [2621 1381 6900] of the Department of Physics, Fudan University, Shanghai, and Zhang Jiahua [1728 1367 7520], Huang Shihua [7806 0013 5478], and Yu Jiaqi [5713 1367 3825] of Changchun Institute of Physics, the Chinese Academy of Sciences: "Photon-Gated Spectral Hole Burning on Inorganic Material  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$ "; MS received 27 Apr 92, revised 1 Jul 92, supported by the 863 Plan of the State Science and Technology Commission]

### [Text] Abstract

Photon-gated spectral hole burning of the inorganic material  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$  is reported. The mechanism of photon-gated spectral hole burning is described. Burning of multiple holes was carried out and detected at 4.2 K. Gating ratio and hole stability were also measured. Hole erasure and repeatable hole burning have also been realized. The results show that there are more than  $1 \times 10^3$  persistent spectrally burned holes in an inhomogeneously broadened band of a  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$  specimen at 4.2 K.

### 1. Introduction

Laser spectral hole burning was first employed in atomic and molecular spectroscopy in 1971.<sup>1</sup> It can detect the fine and superfine atomic or molecular structures buried in the relatively broad Doppler-broadened absorption bands. In 1974, Kharlamov et al. obtained persistent spectral holes

in a solid.<sup>2</sup> This effect was observed later in numerous organic and inorganic materials. Persistent hole burning (PHB) not only can be used in high-resolution spectral analysis of solid materials<sup>3</sup> but also in optical information storage.<sup>4</sup> Hence, it has attracted a great deal of interest.

There are a number of papers on single-photon hole burning in organic systems.<sup>5,6</sup> The authors have also studied persistent spectral hole burning in THP/PMMA.<sup>7</sup> The biggest deficiency of single-photon hole burning is that the difference between signals with and without holes becomes less distinguishable after taking multiple readings. This limits the number of times the stored data can be read. Two-photon photon-gated spectral hole burning requires the simultaneous illumination of two beams of light of different wavelengths. It only requires an attenuated beam to read the data. Therefore, the stored data would not be destroyed when it is read. This paper reports persistent spectral hole burning in the inhomogeneous absorption band of an inorganic photon-gated material using  $\text{Sm}^{2+}$  as an excitation center through a laser-induced two-step selective photo-ionization process. Stable continuous multiple holes were measured for the first time in a new material  $\text{BaFCl}_{0.5}\text{Br}_{0.5}:\text{Sm}^{2+}$ . Parameters such as hole size, gate ratio and erasability were also determined.

Based on our experimental results, the number of holes that can be burnt for coding at 4 K in  $\text{BaFCl}_{0.5}\text{Br}_{0.5}:\text{Sm}^{2+}$  can exceed  $1 \times 10^3$ . This is vital to information storage using photon-gated spectral hole burning.

## 2. Specimen Properties and Principle of Gating

The specimen was prepared by high-temperature solid phase diffusion. High-purity  $\text{Sm}_2\text{O}_3$ ,  $\text{BaF}_2$ ,  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$  and  $\text{BaBr}$  powders in desired molar ratio were mixed, ground and placed in an  $\text{Al}_2\text{O}_3$  crucible. The mixture was heated at high temperature in a reduced atmosphere for several hours and then rapidly cooled to room temperature. The resultant product is a white powder.

Winnacker et al.<sup>8</sup> discovered photon-gated spectral burning in  $\text{BaFCl}:\text{Sm}^{2+}$ . Gated spectral hole burning uses a narrow-band laser to selectively excite certain energy levels of  $\text{Sm}^{2+}$ ; it excites the ions in resonance with the laser frequency from the ground state to an excited state. At the same time, a wide-band laser (gating beam) is used to further excite some excited ions to  $\text{Sm}^{3+}$ . Thus, a hole is left behind in the absorption spectrum of  $\text{Sm}^{2+}$ . The hole frequency is determined by the first laser.

$\text{BaFCl}_{0.5}\text{Br}_{0.5}:\text{Sm}^{2+}$  has an energy level structure similar to that of  $\text{BaFCl}:\text{Sm}^{2+}$ . A similar method, i.e., using the  $^5\text{D}_1-^7\text{F}_0$  transition for photon-gated hole burning and the  $^5\text{D}_0-^7\text{F}_0$  emission spectrum for measurement, as shown in Figure 1, can be employed.

## 3. Experimental Apparatus and Procedure

Since the specimen is a powder, a fluorescent method was employed. Figure 2 shows the experimental setup. An  $\text{Ar}^+$  laser (Coherent INVA 10) is used to pump a dye laser (CR-599-21). The dye (Rhodamine B) operates in a single-line mode and the line width is 1 MHz. A scanning interferometer is used to monitor the operating mode of the dye laser. Its beam is attenuated to the proper power level and then used in the first hole-burning step. The

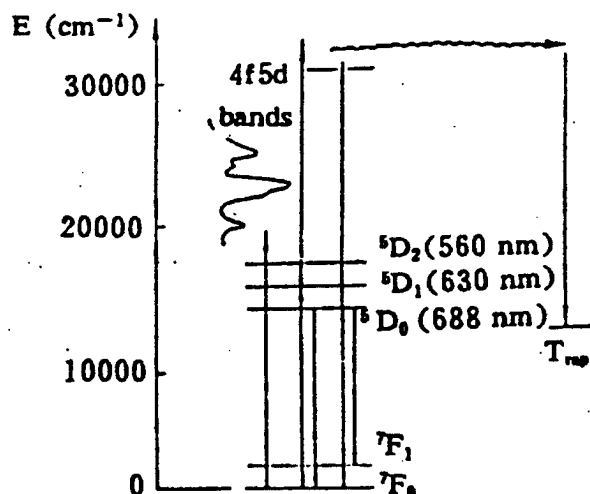


Figure 1. Schematic Energy-Level Diagram for  $\text{BaFCl}:\text{Sm}^{2+}$  Showing Hole-Burning Scheme for Some  $4f^6$  Excited Electronic States and Indicating Scheme Principle Emission Detected During Read-Out for Each

wavelength of the  $\text{Ar}^+$  laser is 514.5 nm. A portion of this beam is split by a splitter and then attenuated as the gating beam in the second step of hole burning. Only the dye laser is used to measure the holes. In this case, the power of the laser beam is one order of magnitude lower than that of the beam used for hole burning. A 44-W monochromator is used to determine the laser wavelength. The fluorescent signal is measured with a grating monochromator (Jobin Yvon HR-1500) and a photomultiplier. The signal is amplified by a phase lock-in amplifier (SR-510) and then sent into a microcomputer (ASTP286). The computer processes the data and either stores or prints out the results. The computer can directly perform frequency-controlled scanning of the dye laser through the lock-in

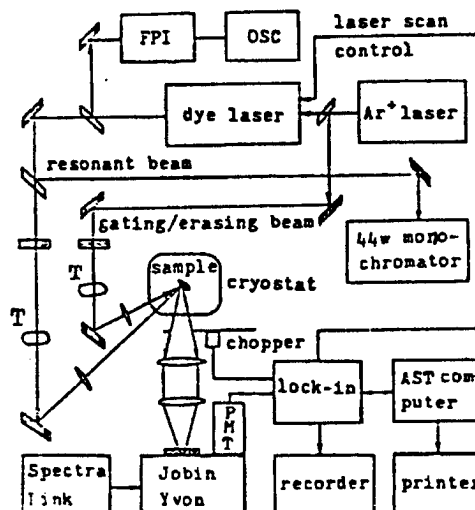


Figure 2. Schematic Illustration of Experimental Arrangement for Hole Burning and Detection

amplifier. The specimen is stored in a Dewar at 4 K. In the figure, T is a timer that controls hole-burning time.

In order to obtain the precise energy-level structure and transition wavelength, the  $\text{Ar}^+$  is used as the light source of non-selective excitation to measure the emission spectrum in order to determine the hole-burning wavelength and the fluorescent wavelength range for hole detection.

In this work, the hole-burning transition chosen is  $^5\text{D}_1\text{-}^7\text{F}_0$ . Prior to hole burning, the excitation spectrum of  $^5\text{D}_1$  was measured first by tuning the dye-laser wavelength near the center wavelength of  $^5\text{D}_1$  and then performing a scan in order to receive the fluorescence from  $^5\text{D}_0 \rightarrow ^7\text{F}_0$  or  $^5\text{D}_0 \rightarrow ^7\text{F}_1$ . This provides us with the inhomogeneously broadened line width of  $^5\text{D}_0\text{-}^7\text{F}_0$  at low temperature. Multiple holes were then burned at different positions within this inhomogeneously broadened band.

Holes could be detected by attenuating the dye laser further and then running the  $^5\text{D}_1$  excitation spectrum again just prior to hole burning. The spectrum would show whether holes are present or not.

#### 4. Results and Discussion

A study of the material shows that an inhomogeneously broadened band of the excitation center could be achieved by crystal mixing. For instance, using  $\text{BaFCl}_x\text{Br}_{1-x}$  as a substrate and varying  $x$  from 1 to 0, the material remains in a single-crystal phase. As the Br content increases, the lattice constants become larger, causing the center wavelength of the  $\text{Sm}^{2+}$  absorption band to shift. At  $x = 0.5$ , the inhomogeneous broadening reaches its maximum.

Figure 3 shows the fluorescence spectrum of the  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$  powder specimen upon non-selective excitation with the 514.5-nm  $\text{Ar}^+$  laser at room temperature. The upper part is the excitation spectrum upon selective excitation of the  $^7\text{F}_0\text{-}^5\text{D}_1$  transition using the dye laser at approximately 630.0 nm. This spectrum was measured by setting the monochromator at its maximum slit width of 3 nm at 688.8 nm to receive the  $^5\text{D}_0\text{-}^7\text{F}_1$  fluorescence. Since there is Br doped into  $\text{BaFCl}\text{Sm}^{2+}$ , the half-width of the inhomogeneous broadening of  $^5\text{D}_1\text{-}^7\text{F}_0$  is approximately 0.9 nm, or equivalent to over 700 GHz, at 4 K. This is much wider than the 13 GHz for  $\text{BaCl}\text{Sm}^{2+}$ . In the experiment, the laser beam has a wide band (0.01 nm), a wavelength of 629.9 nm, and a spot diameter of 3 mm. The gating light used in hole burning is the 514.5-nm  $\text{Ar}^+$  laser line at a power of 30 mW. The  $^5\text{D}_0\text{-}^7\text{F}_1$  fluorescence was detected at 688.0 nm. The hole-burning time is 300 seconds and a wide-band hole was obtained (see dotted line in the figure). The hole depth is approximately 50 percent and its width is close to 0.05 nm. This indicates that this material has excellent hole-burning properties. Furthermore, if multiple holes are to be burned in this inhomogeneously broadened band, a narrower-band laser beam must be used.

Figure 4 shows the results of hole burning with a single beam (hole-burning light) and with two beams (hole burning and gating) in 20 seconds. The optical power density for hole burning is  $2.2 \text{ W/cm}^2$  and that of gating is  $0.8 \text{ W/cm}^2$ . Based on this figure, the ratio of area of two-photon-gated hole burning to area of single photon-gated hole burning is approximately 30. Of course, the

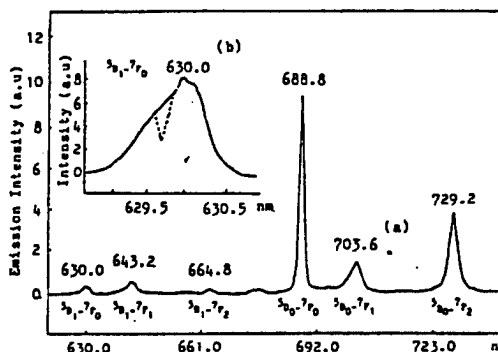


Figure 3. (a) Fluorescence spectra of  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{Sm}^{2+}$  at 4 K. (b) Excitation spectra of  $^7\text{F}_0\text{-}^5\text{D}_1$  transition before (solid line) and after (dotted line) gated hole burning with dye laser line width of 7.6 GHz

gating ratio can be further improved by controlling the power densities of the two laser beams and the burning time.

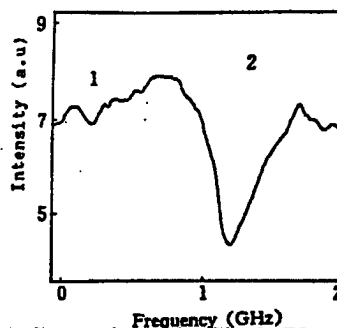


Figure 4. A Comparison of a Single-Photon Burning With Photon-Gated Hole Burning Showing a Gating Ratio of 30

It was also found experimentally that a single beam also produced a hole-burning effect, despite the fact that the effect is very weak. In reality, this is due to a two-photon process from the same beam. Two hole burning photons excite the  $\text{Sm}^{2+}$  ions to a nearly ionized state. Hence, there is a certain probability of ionization to result in hole burning. If a lower hole-burning energy level is chosen and the material is improved, then a higher gating ratio can be achieved to overcome the one-photon hole burning effect.

Figure 5 shows three holes burned at different frequencies using a 3-mm-diameter spot, 11 mW, 630.3-nm dye laser with a line width of 1 MHz and a 2-mW gating beam at 514.5 nm. The hole-burning times are 30, 60, and 80 seconds, respectively. During hole measurement, the laser scan range is 2 GHz. (The figure shows a 1-GHz range.) The widths are 70, 85, and 120 MHz and the depths are 11, 15, and 31 percent, respectively. The relation of hole width and hole depth to burning time is similar to that of organic materials.<sup>8</sup>

Figure 6 shows 15 holes burned within a 6-GHz range near the middle of the 629.70-nm profile. All 15 holes are

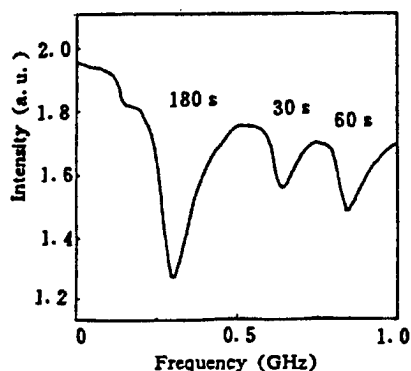


Figure 5. The Relation of Hole Depths and Hole Width to Burning Time

clearly shown. The hole width is 120 MHz and the spacing between holes is approximately 300 MHz.

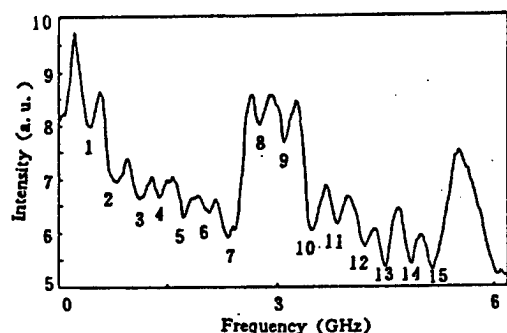


Figure 6. Fifteen Holes Burned Near the Center of  $^5D_1$ - $^7F_0$  Transition at Wavelength 629.72 nm, Laser Scan Range Was Approximately 2 GHz

Holes 8 and 9 in the figure exhibit stronger fluorescence intensity compared to other holes. This is because the specimen is immersed in liquid helium, which continuously evolves bubbles due to evaporation. Occasionally, a few large bubbles showed up in the optical path to cause large fluctuation in the fluorescence intensity. In spite of it, the information stored in the fluctuation is still clearly visible. If the evaporation of liquid helium can be stabilized to avoid disturbance due to large bubbles, the signal-to-noise ratio can be improved, as shown in Figure 7.

Figure 7 shows eight holes burned on one side of the inhomogeneously broadened band corresponding to 630.02 nm. The result shows that all holes were burned through and the holes are clearly visible. The depth ratio is essentially consistently 12 percent. The hole width and hole spacing are identical to those of the 15 holes. Eight holes were burned on the other side of the band and produced the same results. From Figure 3, the inhomogeneously broadened band is more than 0.9 nm, i.e., greater than 700 GHz; if each hole is 120 MHz wide and the hole spacing is 300 MHz, then more than 1,000 holes can be burned in this band. Obviously, the narrower the hole is, the more holes can be burned to store information.

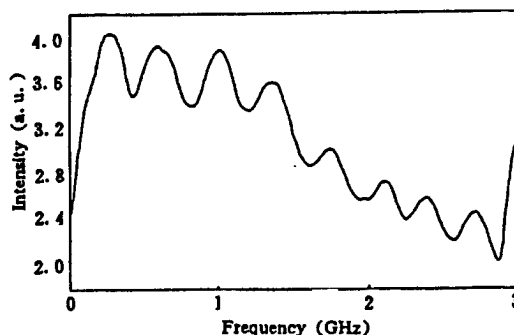


Figure 7. Eight Holes Burned in One of Sides of  $^5D_1$ - $^7F_0$  Transition Profile

In the experiment, erasure of photon-burned holes was also investigated. Upon irradiation of the specimen with the 514.5-nm  $Ar^+$  laser, the information storage holes were found to be erased. The erased holes still have write and read functions. This hole-erasure effect is due to the excitation of  $Sm^{2+}$  by the 514.5-nm light to the  $4f^65d$  continuous band followed by the relaxation to the metastable state  $^5D_1$ . Afterward, it absorbs another photon to ionize an electron. This electron is captured by  $Sm^{3+}$  to produce the hole-filling effect.

In order to study the stability of information stored in photon-gated spectral holes, continuous long-term automatic scanning with the detection laser beam was performed. Figure 8 shows a portion of the data obtained after over half an hour of continuous monitoring of burned holes. (At low temperature, the laser is more stable and the scanning can be lengthened.) (The figure shows five continuous sweeps, each scan is 3 GHz and lasts 25 seconds.) These results indicate that the spectral information stored in photon-gated burned holes has excellent stability. This is significantly better than single-photon burned holes where information stored will be erased after repeated scanning.

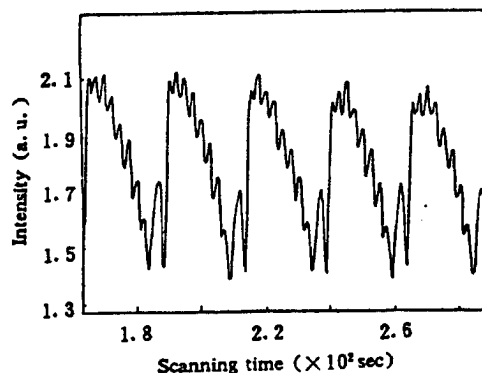


Figure 8. The Stability of Photon-Gated Spectral Hole Burning Was Detected by Repeated Scanning of 3 GHz/25 sec of the Laser Over the Burning Range

## 5. Conclusions

It was found that mixed-crystal materials can produce an inhomogeneously broadening effect. The half width of

$\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{:Sm}^{2+}$  was measured to be 700 GHz in this work. This is much higher than the 13 GHz found with  $\text{BaFCl:Sm}^{2+}$ .

For the first time, 8 and 15 holes were burned continuously on one or either side of the inhomogeneously broadened band. The holes produced are crisp and have a high signal-to-noise ratio. In addition, continuous scanning of the holes was done over a long period of time for the first time. It was proved that photon-gated spectral hole burning is an extremely stable scheme for long-term storage of information.

On the basis of our experimental results, it is estimated that more than  $1 \times 10^3$  spectral holes can be burned in the inhomogeneously broadened band of  $\text{BaFCl}_{0.5}\text{Br}_{0.5}\text{:Sm}^{2+}$  at 4 K.

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## MICROELECTRONICS

### Investigation of PL Linewidth, Quantum Size Effect of InGaAs/InP Quantum Wells Grown by LP-MOCVD

40100100A Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 6, Jun 93 pp 345-352

[English abstract of article by Chen Deyong, Zhu Longde, Li Jing, Xiong Feike, Xu Junying, Wan Shouke, and Liang Junwu of the Institute of Semiconductors, CAS, Beijing 100083; MS received 28 Jan 92, revised 22 Apr 92]

[Text] Single and multiple InGaAs/InP quantum well structures were grown by MOCVD at 50 mbar. Photoluminescence (PL) method was used to characterize the relation between the exciton energy shift and the well width caused by quantum size effect. The energy shift of a 7-Angstrom quantum well was as high as 370 meV. Considering the nonparabolic nature of the bands, we took  $Q_c = \Delta E_c / \Delta E_g = 0.4$ , and got a curve for energy shift and width, which was a good fit for the experimental points. Virtual Crystal Approximation (VCA) method was applied to discuss the dominant mechanism for the linewidth broadening over the extent of exciton. With the interface microscopic fluctuations  $\delta_1 = 2.93$  Angstroms,  $\delta_2 = 100$  Angstroms, and the radius of the cluster in the alloy  $R_c = 3$  ML, variation of the exciton PL linewidth  $\Gamma$  as a function of

well width  $d$  was obtained, which was also a very good approximation to the experimental results.

### Optical Evidence of Carrier Resonant and LO-Phonon-Assisted Tunneling in Asymmetric Coupled Quantum Wells

40100100B Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in Chinese Vol 14 No 6, Jun 93 pp 390-394

[English abstract of article by Xu Shijie of the National Laboratory for Superlattices and Microstructures, Institute of Semiconductors, CAS, Beijing 100083 and Department of Electronic Engineering, Xi'an Jiaotong University, Xi'an 710049, Jiang Desheng, Li Guohua, and Zhang Yaohui of the National Laboratory for Superlattices and Microstructures, Institute of Semiconductors, CAS, Beijing 100083, and Luo Jinsheng of the Department of Electronic Engineering, Xi'an Jiaotong University, Xi'an 710049; MS received 8 Oct 92]

[Text] Tunneling phenomena of electrons in a biased GaAs/Ga<sub>0.65</sub>Al<sub>0.35</sub>As/GaAs asymmetric coupled quantum well (ADQW) structure has been investigated by using steady-state photoluminescence. The effects of resonant tunneling and LO-phonon-assisted tunneling for electrons from the narrow well to the wide well have obviously been observed. It has also been demonstrated that AlAs-like LO phonons from the GaAlAs tunnel barriers play a dominant role in the LO-phonon-assisted process.



**Superconducting Josephson Voltage Standard,  
Determination of  $2e/h$  Value**

40100098A Beijing DIANZI XUEBAO [ACTA  
ELECTRONICA SINICA] in Chinese  
Vol 21 No 5, May 93 pp 82-84

[English abstract of article by Zhou Gengru and Zhao  
Guifen of the 203 Institute, the Ministry of Aerospace,  
Beijing 100854; MS received Aug 91, revised Nov 92]

[Text] This paper describes the measurement system of  
10 mV superconducting Josephson voltage standard  
developed by our institute. The total uncertainty of the  
system is  $24 \times 10^{-8}$  and its random uncertainty is less  
than  $1 \times 10^{-8}$ . In April 1988, the  $2e/h$  value in SI Unit is  
precisely determined as 483597.88 GHz/V. The differ-  
ence between our result and international adjustment is  
only  $4 \times 10^{-8}$ . Because it possesses very high accuracy and  
reliability, the system was ratified as National Tempo-  
rary Voltage Natural Standard by National Monitoring  
Bureau of Technology and was formally put into opera-  
tion in August 1992.

**TELECOMMUNICATIONS R&D**

**Sino-U.S. B-ISDN System JV Established**

93P60290A Beijing BEIJING KEJI BAO [BEIJING  
SCIENCE AND TECHNOLOGY NEWS] in Chinese  
2 Jun 93 p 3

[Unattributed article: "China, U.S. Joint Venture To Build  
Telecommunications Network System"]

[Summary] The U.S. firm SCM/Bu-lu-ke-si [phonetic;  
?Brooks] Telecommunications Co. and the Chinese firm  
Galaxy New Technologies Co. on 5 May formally  
announced their establishment of a joint venture (JV) in  
the networked systems area: a high-tech telecommunica-  
tions networked system will be constructed in southern  
China. The JV enterprise office, located in Guangzhou,  
will design, build, and market a commercial and civilian  
broadband integrated services digital network (B-ISDN)  
system. It is estimated that the cost of this system will  
exceed US\$1 billion, and that initial construction will  
begin in January next year, with formal operation of the  
entire system to begin in January 1995. The U.S. firm's  
Chairman of the Board Adlai Stevenson remarked that the  
new JV will bring annual revenues of several US\$ billion to  
U.S. telecommunications equipment manufacturers. It is  
understood that the China telecom equipment market and  
its annual revenues of US\$20 billion take first place  
worldwide.

**Beijing C-System INMARSAT Ground Station  
Operational**

93P60295A Beijing RENMIN RIBAO OVERSEAS  
EDITION in Chinese 6 Jul 93 p 1

[Article by Jiao Xin [3542 0207]: "Beijing International  
Maritime Satellite Station C-System Satellite Communica-  
tions Operational"]

[Summary] Following upon the formal inauguration of  
INMARSAT A-system satellite mobile communications  
on 3 June 1991, the Beijing INMARSAT ground station

formally began C-system satellite communications on 1  
July [1993]. This system, which provides a number of  
digital communications services—including search and  
rescue and other emergencies—for customers at sea, on  
land, and in the air, is accessible via small, lightweight,  
portable terminals.

**Progress Made in Communications Satellite  
Research**

OW1307035493 Beijing Central People's Radio Network  
in Mandarin 2230 GMT 11 Jul 93

[From the "News and Press Review" program]

[Text] China has made significant progress in satellite  
research. The telecommunications capacity of the new  
generation satellite will be six times greater than the earlier  
telecommunications satellites and its designed lifespan will  
be 4 years longer, reaching 8 years.

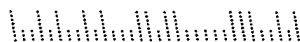
According to the No. 504 Research Institute under the  
China Corporation of Aerospace Industry—which  
develops and builds the satellite—the development of  
Dongfanghong [the East Is Red] III—China's telecommu-  
nications satellite of the new generation—is at its final  
stage. The new satellite has 24 transmitters, or 20 more  
than the satellite China launched in 1988. This new  
telecommunications satellite, which will be launched in  
spring next year, can transmit six color television programs  
and 12,000 bidirectional telephone calls simultaneously. It  
also has the capacity of transmitting radio programs and  
facsimiles of telegraphs, newspapers, and pictures.

Moreover, the development of China's meteorological  
satellite of the new generation—the Fengyun II—has also  
been completed at the No. 504 Research Institute. This  
first geostationary meteorological satellite China has suc-  
cessfully developed can take infrared meteorological pic-  
tures about water vapor and lightning, and it is significant  
for improving China's weather forecasts.

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